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EURASIA.

By SARA JEANNETTE DUNCAN.

NOTE.—"*Cutcha*"—inferior. "*Burra lord sahib*"—Great lord sahib—the viceroy. "*Dall*"—pulse. "*Dhoty*"—loin-cloth. "*Jat*"—race. "*Syce*"—groom. "*Qui hai!*"—call to servants—"Whoever is there?"—facetious name for old Anglo-Indians. "*Baboo*"—educated Bengali. "*Bearer*"—personal servant. "*Kitmutgar*"—table-servant. "*Musalchi*"—washer of dishes. "*Talub*"—wages. "*Tum bai-adab hai*"—"You are without respect." "*Durzie*"—native tailor. "*Belati*"—foreign. "*Gharries*"—carriages.

FROM a back window of my tall house in Calcutta I see her nearly every day, the lady who may personify Eurasia. She is amply qualified to do it; Nature in molding her permitted her to lack no characteristic that could contribute to make her a generous racial type. She is cast upon the comfortable lines common to her people—lines that could not be indicated in avoirdupois under two hundred-weight. They are more evident to me than even this statement of fact can make them to the public, since Mrs. De Souza—her name is De Souza—is usually clad, when she comes under my observation, in a casual calico dressing-gown, which leaves little of her benevolent person to be invented. The dressing-gown is open at the throat on account of the temperature, but in compensation there is a great deal of it at the other end; it is *en traine* and has a flounce. Once, doubtless, it ministered to her vanity, for even at that age—she is turned fifty—and at that weight, Mrs. De Souza and vanity are not incompatible. There is Mrs. De Souza's complexion, for example—she has always been very properly vain of that. It is quite an exceptional complexion, oatmeal in tone. Eurasia, which verges from that to mahogany, considers Mrs. De Souza "fair," and her claims to

social privileges rest very much upon this opinion. She and her family live in a small, flat-roofed, "*cutcha*"-built habitation, much stained and faded, standing flush with one of the many narrow streets that creep and wind among all Calcutta's tall houses, even to the skirts of the stately residence of the "Burra lord sahib" himself. It is very hot, stifling, in those crooked little streets; the pleasant south wind does not always blow through to sweeten them, and they bear much need of sweetening. They cause Calcutta's Municipal Council more anxious hours than is the province of thoroughfares, on account of the prosperity of bacilli in their midst; and though the Municipal Council conspired all day, and sat up all night, taking measures of reprisal, the bacilli would still be glad and the inhabitants would still decrease. Not appreciably, however; there are far too many of them. Such numbers of little open shops, uninviting little shops, where rice and *dall* and sticky brown sweetmeats are piled up in earthen bowls to catch all the uncleanness of the roads! Such numbers of proprietors to each little shop, who sit on their dusty thresholds, as often as not with their glistening bare backs turned to custom, gossiping about the monsoon, taking turns at the gurgling cocoanut of the hubble-bubble! And then the comers and the goers, turbaned and bareheaded, dressed in the flowing robes of the Prophet or the simple *dhoty* of the coolie-lok, all upon the various interminable little businesses by which they gain leave to live—to say nothing of Mrs. De Souza's own family, which is large, or of her social connection, which stretches, interspersed by the little shops, all the way down the street. But I must deny myself the pleasure of referring to Mrs. De Souza further in this personal strain. It is, after all, contrary to the ethics of good neighborhood that I should take any great advantage of an upper window, in spite of the generous publicity of my neighbor's domestic arrangements, which seem to invite both inspection and report. I must hurry unflinchingly on to say that Mrs. De Souza inhabits another world than the little Anglo-Indian one, a world with mysterious affinities and attractions, however, both for ours and for the great dusky tropical swinging sphere of the pure "native." Nobody knows it very well that I have heard of; indeed, it would require some courage to profess familiar acquaintance there; but it is quite within reach of astronomical observation, which is not compromising.

Eurasia has no boundaries. It lies, a varying social fact, all over India, thick in the great cities, thickest in Calcutta, where the conditions of climate and bread-winning are most suitable; where, moreover, Eurasian charities are most numerous. Wherever Europeans have come and gone, these people have sprung up in weedy testimony of them—these people who do not go, who have received somewhat in the feeble inheritance of their

blood that makes it possible for them to live and die in India. Nothing will ever exterminate Eurasia; it clings to the sun and the soil, and is marvelously propagative within its own borders. There is no remote chance of its ever being reabsorbed by either of its original elements; the prejudices of both Europeans and natives are far too vigorous to permit of much intermarriage with a *jat* of people who are neither one nor the other. Occasionally an up-country planter, predestined to a remote and "jungly" existence, comes down to Calcutta and draws his bride from the upper circles of Eurasia—this not so often now as formerly. Occasionally, too, a young shopman with the red of Scotland fresh in his cheeks is carried off by his landlady's daughter; while Tommy Atkins falls a comparatively easy prey. The sight of a native with a half-caste wife is much rarer, for there Eurasian as well as native antipathy comes into operation. The whole conscious inclination of Eurasian life, in habits, tastes, religion, and most of all in ambition, is toward the European and away from the native standards. On the whole, Eurasian prejudices against the natives are probably stronger than European ones, and more unreasoning. The claims of that cousinship must be more than ignored, they must be trampled upon. But, in the matter of marrying and giving in marriage, Eurasia is more than sufficient unto itself, and has been for so many generations that both the native and European characteristics of the type have become largely merged in its own.

There are twenty thousand Eurasians in Calcutta to one third that number of Europeans. Even that does not represent the proportion fairly, for the census-taker probably finds it easier to obtain the true age of unmarried ladies than the confession "East Indian" if "European" can be written with the least shadow of acceptance. They are not hermetically sealed up in offices and closed *gharries* and darkened drawing-rooms during the heat of the day, like the Europeans; they take their walks abroad careless of the sun, in straw hats and such other ephemeral millinery as pleases them. Always they wear *belati*-cut clothes; it is the dear privilege of the poorest and blackest. They share the tram-car with the natives and they walk to their business, distinguished in this way from the sahib, who does neither. Thus one meets them in crowds, but not always thus. Quite often it is in a luxurious landau behind a fair pair of horses, with a coachman on the box and two *syces* behind, that one has the opportunity of observing Eurasia, lying back among its cushions. For Eurasia has its nabobs, and the Red Road knows them as well as it knows the judges of the High Court of Calcutta, or the members of his Excellency's Council. Once a year, only once, at the state ball at Government House, it is possible, if one looks

very carefully, to detect a slight Oriental darkness under the powder on some otherwise unimpeachable cheeks. It is the annual opportunity of rich East India to proclaim itself connected, however remotely, with "society." Society looks on and smiles and covertly inquires, "How many annas, do you suppose, to the rupee?" This is a euphuism expressive of proportion—of Aryan proportion. For the rest, the attitude of society may be expressed by an inveterate shrug. It is not invidious or actively contemptuous; it represents the acceptance of the inevitable, and the determination—if that is not too energetic a term—to have as little to do with it as possible. Society recognizes that Eurasia has certain claims—to charities and commissions of inquiry, to humane treatment, to commiseration, to good advice. It holds meetings, raises subscriptions, discusses the Eurasian problem in the newspapers, and supplies inquiry commissioners from among its most honorable and distinguished. But the claims of Eurasia upon society must be made distinctly *in forma pauperis;* it is only the lower classes who have any. For the well-to-do in the landaus society has only a somewhat amused and cynical toleration, and does not dream of bowing. The attitude is natural enough. For the claims of that cousinship also must be more than ignored—they must be trampled upon.

I have hinted at the amplitude of Mrs. De Souza—it is largely characteristic of Eurasia, more marked, perhaps, in the women than in the men. The dusky chin has a tendency to grow early double—the comfortable shoulder to shake prematurely in the plenitude of what one might call semi-tropical nature. This sometimes carries with it a perfunctory jollity of appearance, the look of well-being that goes inseparably with solid development, the cheerfulness of curves. The prevailing Eurasian expression, however, is not one of exhilaration, at least in Bengal. The Bengali is not merry, and his paler-faced connections have inherited his unsmiling look at life. The few whose color is of a Mongolian strain are gay by contrast, but East India generally is of a sad countenance—languor, lethargy, and depression being oftener written there than anything else. There are easy physical reasons for this. The Eurasian is a poor creature among men. The death-rate of the community is tabulated with that of the European element, so can not be ascertained accurately, but it is known to be high. He is an easy victim to all the diseases that follow poverty and crowded living. He has not such immunity as is enjoyed by the Bengali by virtue of simpler conditions of life; his habits and requirements are of the complex European order, that bring, inadequately gratified, swift consequences, which he lacks the strength of the European to combat. When he is not abnormally fat, the Eurasian is apt to be painfully thin,

with high, narrow, Aryan shoulders, a contracted chest, and a stoop. He almost invariably inherits the straight black hair, soft dark eye, flat cheek-bones, and full curved lips of his Indian forebears, with varying shades of complexion, from what is distinguished with difficulty from the sahib's to what might easily pass for the pure native's. Occasionally, with one parent or even both of dark color, one sees the anomaly of a little fair-haired, blue-eyed child, a whimsical legacy from a bygone generation. Here the "tar-brush" is more painfully in evidence. There is a dinginess about the yellow curls and a dullness in the blue eyes, a smudginess in the general effect, as if Nature had finished her work with a dirty palette. And the brothers and sisters of the pitiful little freak may be as brown as shisham-wood.

It will be seen that it would be easy, if desirable, to convict Mrs. De Souza of her mixed origin in a variety of ways, however "fair" her comely visage. But there remains her East-Indian voice and "accent." It is so marked that if we met Mrs. De Souza in London or New York, more elaborately costumed perhaps than she appears from my window, it would throw about her speech the halo of amused interest which a foreigner's always evokes. We would guess at her nationality; though, unless we were retired Anglo-Indians, we would never hit it. To the rest of us she might have been originally French, or Spanish, or almost anything. It would be only the old "*Qui hai*" who could detect and pounce upon the dulcet "chi-chi," the language of Eurasia. It is English, of course—soft, rapid, nervous English. It is so quick, that the words seem to click against one another as they come; but they never run together; on the contrary they are extraordinarily distinct. There is little disagreeable twang, but there is a great deal of unlooked-for inflection; a rising and falling of tone where we would go monotonously on, which gives almost a picturesque effect to the words, until one tires of it. The sentences are apt to terminate with a certain abruptness; there is absolutely no drawl at the end of them. An odd importance, which is yet not emphasis, is given to the final syllables we tend to slur, and there is an almost invariable tendency to double final consonants. "Kindlee step thiss way," says the young woman behind the counter. "Thiss is verree prittee—and *chip* too *on*lee *one* rupee ae yard." The baboo speaks English in exactly the same way, and it is the common fear of the "country-bred," the pure European born and brought up in India among the hills, to acquire it. It is fatally easy to imitate, though extremely difficult to transfer to print, and makes one reason the more why Anglo-Indian children should be early sent home to be educated. Pleasant enough while it is novel, it soon becomes objectionable to European ears, doubtless as a matter of asso-

ciation, for in itself it is artless babble enough. Nor is there in it the remotest flavor of cockneyism. The dwellers in Eurasia, poor souls, are born much too far from the sound of Bow Bells. It abounds in odd words and phrases, some of them distinctly related to the native tongues, some of them pure English with a local application. To see a friend off is to "carry her to the station," whether walking or driving. When the *syce* is ordered to unharness his animal he is expressly told to "open out the horse"; while "of course" is to Eurasian what "indeed" is to Virginian, the common accompaniment of every yea and nay.

It is a hard saying, but it suffers little contradiction, that morally the Eurasians inherit defects more conspicuously than virtues from both the races from which they spring. Drunkenness is not common among them, nor is brutality. As boys they do not rob birds' nests or torment animals or fight, and they never grow up into sportsmen. The more aggressive vices do not flourish among them. But their indolence and unthrift are proverbial, as are their cupidity and instability of character. It is characteristic that the truth is not in them, and they have a marvelous ingenuity in manipulating the lie. In this their knowledge of the sahib's sympathies enables them to outdo the Bengali, though their methods are much the same. With beggars a favorite instrument of extortion is a death-certificate—a mother, a daughter, a baby lies dead at home; the funeral is a cruel, pressing, immediate necessity; a little money to meet the emergency is but a small demand upon common humanity. If you are unbelieving, the notice is shown to you in the morning paper—"Suddenly, of cholera, Mabel, infant daughter of Charles and Mary De Rosario"—with convincing tears. It is probable, however, that the death-certificate is well-nigh worn out in the service of misfortune, and that the tearful applicant for means to bury her never saw the infant daughter of Charles and Mary De Rosario. The social evil among the lower classes is very hideous. They seem to have a code of their own, which is capable of infinite infraction, and they touch a level of degradation which is far lower than any reached by the pure heathen about them. This is apparently an ineradicable thing, for it has its root in physical inheritance and its reason is racial.

Life under however modest conditions is impossible to Europeans in Calcutta under a certain income. This is perfectly understood by all employers of European labor, which is used for this reason only in posts of superintendence and responsibility. The European's food and lodging must be of a certain quality; he must have a certain number of servants and certain opportunities for recreation and change to make existence tolerable. The Eurasian will support life, however, upon means of almost vanishing pro-

portions. With anything between one and two hundred rupees a month—the rupee being equal to about one shilling and fivepence—he is fairly comfortable, and a person of respectable position. He can afford to occupy the whole of a small house in a back street, to feed and clothe his family tolerably well, and, with the assistance of one of the charitable educational institutions of Calcutta, to educate them. But the Eurasian is improvident to the core, and will marry, taking no thought for the morrow, upon from thirty to forty rupees a month. The young lady of his species is charming in her way, which the young gentleman naturally finds a very captivating way. She develops early all the arts of beguilement; her eyes are liquid brown, her cheeks soft and round, her figure slim and graceful. Her prettiness is weak and transitory, but she possesses it long enough to insure the reward of her desirability. The matter is submitted to her mother, not her father—in Eurasian households the sway is maternal—and the affair is arranged upon the basis of family community. The young man agrees to live with his mother-in-law, to hand over to her his entire monthly *talub*, and to be provided for, with his wife, much as she thinks fit. His earnings go into a general fund, controlled by the mother-in-law, who is not unfrequently blessed with several married sons and daughters in circumstances that keep them under her roof. She feeds them all and clothes them all, dispensing such luxuries as she may. They increase, but not in riches, and when the multiplication reaches a figure quite disproportionate with that which represents the collective income, the family go over in a body to swell the great piteous majority which forms the Eurasian problem. Their accession to it is often hastened by a peculiarity of temperament on the part of the wage-earner, who is apt upon the slightest provocation to throw up his situation, no matter with what difficulty it has been procured or can be duplicated. His vanity and love of display tempt him to curious extravagances. On the occasion of a wedding or a christening he will spend his last *pice* with a generous trust in Providence for the commonplaces of food and drink in the days that come after. His family affection is a marked characteristic. Parents cling to their children with a degree of sentiment apt to be common among people who have too many, and often this attachment stands with foolish obstinacy in the way of the welfare of its object.

Notwithstanding their lack of thrift and strength, the most obvious reason for the great poverty and distress among the Eurasians lies in the tremendous competition of the natives. There is almost no department of labor in which it is not felt. The East Indian is particularly fitted by nature and inclination for minor clerkships; and here he finds in the baboo, who also loves an office

seat and a pen, a formidable rival. The baboo is cheaper, his attainments are quite as good, and it is to be feared that the sahib prefers his services also because he can be "jumped upon" with a better conscience. In small shopkeeping the native undersells the Eurasians because he can underlive them, and has almost the whole of the trade of Calcutta which is not controlled by larger European firms, in his hands. A few of the women are employed as nurses in European families, but a Eurasian nurse is an expensive luxury, as she must be fed as well as paid at a higher rate than an *ayah*, while she often demands a native servant to assist her. Here, however, she offers a *quid pro quo*—her services are more valuable than an *ayah's*. The Eurasian has no chance against the native, however, in any other department of domestic service. The native is fitted by nature and education to serve the sahib; the position is one of dignity, and rather enhances the respect he receives from his fellow, however high his caste. He does, as a rule, only one thing, whether it is the work of a bearer or a *kit-mutgar*, or a *mussalchi*, or a *syce*, and, as its performance leaves him ample leisure to attend to his private comfort, he does it well. His whole habit of mind, moreover, is one of deference to his superiors; his own self-respect is bound up with it; "*Tum bai-adab hai!*" is a keen reproach. No European would dream of employing a Eurasian servant in preference for reasons of pure comfort. But, curious as it may seem, Eurasia scorns household service, and declines to compete with the native on what is so obviously his own ground. In fact, however poor, the Eurasian reckons one or two servants among the necessities of his own existence. The beggar of this race will approach your gates in a *palki* borne by four of his muscular Bengali cousins. The Eurasian "lady" who implores a little pecuniary assistance often sends her appeal by a peon—and on scented paper. Poor Eurasian lady! she is denied even the resource of her sex the world over—her needle—for the *durzie* sews better and cheaper than she.

It goes without saying that the East Indian is unable to work all day in the sun with the scantily clad coolies at the roadside or the docks, even if a man with any strain of European blood in him would consent to give the strength of his arm under such conditions for fourpence a day. Behind "*belati*" counters he holds his own, and so does she, by reason of their superior knowledge of the wants and tastes of the sahib and the memsahib. The railways are an invaluable source of employment for them, and they are found more useful than the natives in positions of minor responsibility—in warehouses, docks, and the customs. A small and very respectable proportion of them also find employment as teachers; and some make their way to the up-country tea and indigo plantations, where a certain number suc-

ceed, though the race has not the physical qualifications to make such a resource general. And, of course, there are the saving few, who make their business successful whatever it is, and rise to positions of moderate affluence and general respect. In spite of all this, however, the Eurasian element of the population of Calcutta has become so large, and the problem presented by its condition so pressing, that a special commission has recently been appointed by Government to inquire into its circumstances and devise some means to make them less distressing. Among other remedies it is proposed to utilize Eurasian youths for military purposes, and to make certain Government appointments more easily accessible to them. But the problem will doubtless always remain a problem, presented by the remorseless operation of natural and economic laws, and only tampered with, more or less futilely, for the sake of a common humanity by the efforts of philanthropy.

Now that I have finished my imperfect sketch, the ink in which I have drawn it seems too black. After all, there is a great deal of red blood in Eurasia; sometimes, indeed, the admixture of the other color is so slight as to completely impose upon society, knowing as society thinks itself. In the heart of Eurasia—a heart which has yet to be bared to us by the scalpel of modern fiction—surely may be found much that is worth adding to the grand total that makes humanity interesting. On the other side of a prejudice, well founded and well built, who knows what fruits may drop and what flowers grow? Nothing is more certain than that we can not see over it.

I met Mrs. De Souza only this morning, in the bazaar. She was buying fruit and vegetables, and she argued with great fluency and decision about their price. The brown Bengali vendors of these things quailed before her; she understood to a thread the construction of the web of their duplicity. In the end, she got all she wanted at about two thirds of the price I should have been obliged to pay—and I know the bazaar. It is the *dustur*, the impenetrable, unassailable *dustur*, for the *kala mem* to pay less for everything. She was accompanied by two Miss De Souzas, who did not pay much attention to the fruit and vegetables. Very smart were the Miss De Souzas, all in pink and blue, for it was Sunday morning, and on Sunday morning Eurasia is *en promenade* at the bazaar. Also I saw two very elegant young men, with dapper sticks and fresh ties, looking smilingly in their direction. And just outside, high in a swaying sago palm, three hoarse old crows told each other what would certainly happen.

THE NATURAL OR SCIENTIFIC METHOD IN EDUCATION.*

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EDUCATIONAL methods seem to have been devised in the past more to meet the real or fancied requirements of practical life than with any clear reference to the constitution of the human mind, and this has been owing in no small measure to the reflex influence of public opinion. The school was, and by many still is, regarded as a place where that is to be learned, and pretty much that only, which it is thought will enable the pupil to earn a livelihood or prove successful in the struggle for material things; and of course, so far as it goes, this view is of vital importance. Unhappily, it overlooked the highest purpose of life, and so regarded it is a severe commentary on the character of our age. It has proved a short-sighted policy. It has defeated even its own ends. That can only be a sound theory of education which takes into account, what Nature herself always does, the organism and the environment. Why is our age so advanced in science? The human brain is essentially the same sort of a mechanism it always was, within the knowledge of men. The change is due to difference in method. The moderns have achieved their great results by the scientific method, the Baconian method of induction, or, as we usually say now, the experimental method.

Education has given us the results of a series of experiments, and we are trying others to-day; and at this point I would like to insist that educational questions can only be settled by experiment. Many theories that looked fair have proved delusive when actually tested by experience. But one thing is perfectly certain: any theory or any practice which does not square with the organization of man and the nature of his surroundings or environment, will be a failure just in so far as it falls short of meeting both. The difficulty is to know the nature of our own organization, and knowing that, to adapt it to our environment, or, as we usually say, to our circumstances. Allow me to use the term environment because it applies to other animals than man, and I desire to give my treatment of the subject as broad a basis as possible. From the time that men began to think they studied themselves, and long ago the Greek wisely asserted that to know one's self was the sum of all wisdom; and, of course, in the widest sense, for a man to know himself is to comprehend his relations to the entire universe.

* The main portions of an address delivered under the auspices of the Royal Society of Canada, at its annual meeting in Ottawa, in May, 1892.

Why are we then, after all those ages, still at work on the problem? Why have we made so many blunders as the history of educational methods shows? Are we in any more hopeful position to solve the question to-day than ever before? Without in any way underestimating the efforts of the past, or being oversanguine as to a complete and speedy realization of perfection in education, I venture to think that we are now at last, if not actually on the right road, at least getting closer to it. We have begun to apply the inductive or scientific method to education because we apply it to ourselves. Modern physiology and psychology are, I venture to think, destined to revolutionize our edu-

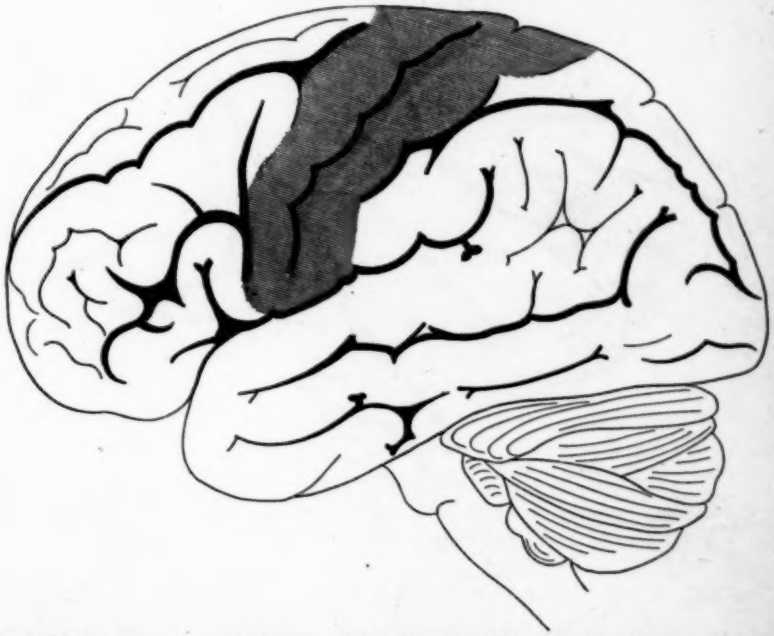

FIG. 1.—OUTER SURFACE OF CEREBRUM (after Exner). The shaded portion represents the motor area in man and the monkey—i.e., the area which most observers believe to be associated with certain voluntary movements of the limbs, etc.

cational methods. Certainly, until we study closely the physical organization, and especially the brain of man, we are far from scientific theory and practice in education, because without this a true psychology is impossible. In other words, educating the mind wisely depends on understanding its nature. This can only be accomplished by a study of our physical organization also, especially of that organ through which the mind expresses itself. So far as we know, brain processes and mind processes are always correlated. Cut off the blood-supply from the brain and the subject becomes unconscious, because thereby the subtle molecular processes or movements that we term functioning suffer to such

a serious extent. When we speak of mental weariness we really refer to brain weariness, or more accurately to alterations in the delicate machinery of brain-cells. The brain itself is affected by the condition of the rest of the organism. A man with wearied muscles, or blood starving for oxygen, can not think well.

These illustrations may suffice to explain my general attitude, that to study educational methods scientifically we must betake ourselves to an examination of the human brain. Fortunately, within the last twenty years brain physiology has made great

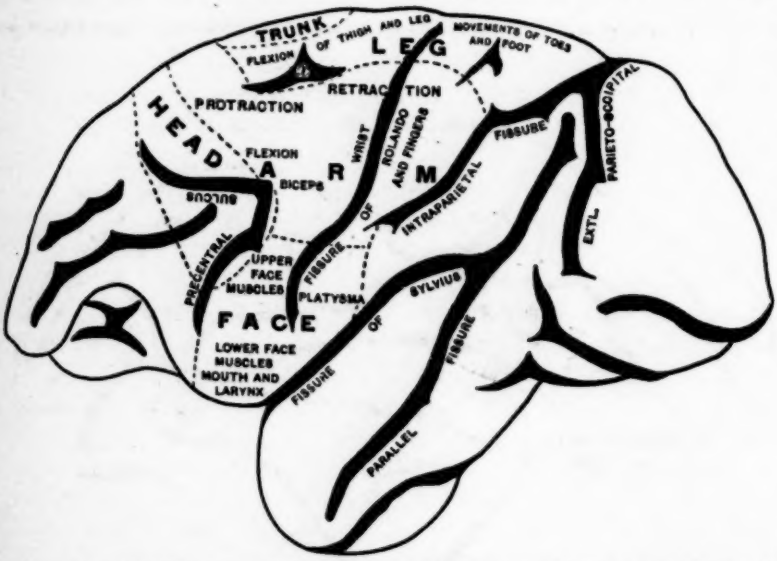

FIG. 2.—LATERAL SURFACE OF BRAIN OF MONKEY, DISPLAYING MOTOR AREAS (after Horsley and Schäfer).

progress, owing to the investigations of anatomists, physiologists proper, pathologists, and practicing physicians. The chief advance has been in the direction of extension and accuracy of knowledge as to the function of the gray matter on the surface of the brain, the so-called cortex. The functions of nearly every region of this cortex are now known approximately, and as regards some areas with great accuracy; so much so that surgeons have, in consequence of a diagnosis of the site of an irritation or of pressure, been enabled to cut down on the very spot affected and so relieve the patient.

The region which we least know is just that about which the phrenologists have had so much to say, and mapped out to their own satisfaction with great precision. Of this region physiologists can as yet draw conclusions only by a sort of process of exclusion.

We know very definitely the *motor area* concerned in volun-

tary movement, and we know approximately, but with less accuracy, the *sensory area*—i. e., the region essential to sensory processes. It will be seen from the accompanying diagrams that all the posterior half of the brain surface is, we may say roughly, sensory; and that it has been provisionally subdivided into regions for vision, hearing, tasting, etc.* If the surface at these points were crushed, pressed upon, replaced by a foreign growth, or removed by accident, there would be a corresponding mental loss—blindness, deafness, etc.

It is important to notice what a large part of the cortex is concerned with sensory processes, for it suggests in the strongest way that sensation must play some very great part in our mental life, and this modern psychology now most clearly recognizes. In fact, the extent of our sensory activity determines in great meas-

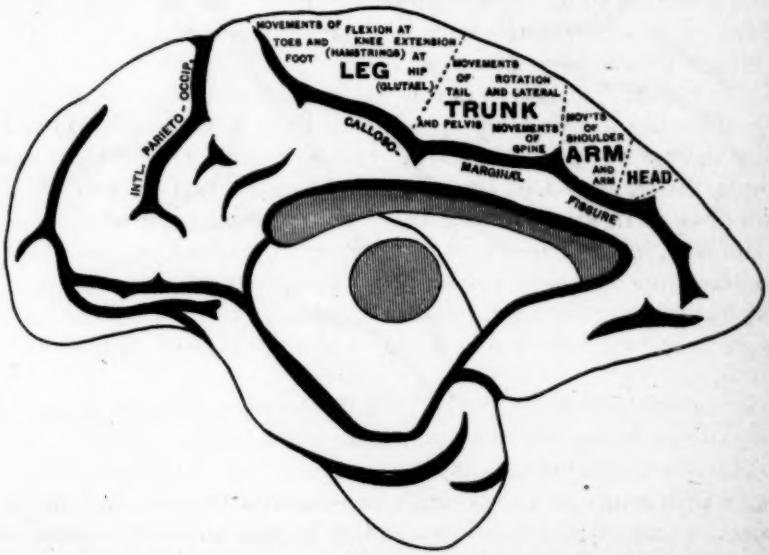

FIG. 3.—MEDIAN SURFACE OF BRAIN OF MONKEY (after Horsley and Schäfer). Figs. 2 and 3 may be said to embody the views of Horsley and Schäfer more especially in regard to motor localization.

ure the degree of our consciousness, for there are all degrees of consciousness, from a maximum down to such a condition as we find in sleep, which has its degrees also.

The case of the boy that had but one seeing eye and one hearing ear, and who could at any time be put to sleep—i. e., rendered unconscious—by closing up the avenues of sense, is very instructive.

It will further be noticed that localization of function conse-

* The figures in this article are taken from Mills's Comparative Physiology. D. Appleton & Co., New York, 1890.

quent on this anatomical delimitation of brain areas is very important. Apart from this it is not possible to conceive of that restriction of the attention to one kind of sensory impressions that is essential to clear perceptions. All teachers know the importance of securing attention; but, unfortunately, this is too often confounded with a constrained attitude and other non-essential accompaniments.

But a sound physiology and psychology should correspond to Nature. About the best way to test them will be to ascertain how they fit into human nature before it is influenced by any methods whatever, for all methods are liable to hamper and modify. It is hopeful to notice that so many psychologists of the modern school are turning to infant psychology, or the study of the mental development of the very young child, which is of course closely related to its physical development. The behavior of the infant is in accordance with the brain structure and function of which I have been speaking.

The infant from birth is the subject of almost constant movements during the waking hours of its life—movements which are spontaneous and not voluntary. Some of these movements, at all events, are reflex—i. e., the nervous discharges from the central cells of the brain and spinal cord which cause them are not due to the will, but to some sort of external stimulus; and so great is the tendency to these nervous discharges in the young animal that but the slightest stimulus is required. Some of these movements may be considered a continuation of those of the pre-natal period.

It is doubtful if the newly born infant executes any voluntary movements, because will proper it does not then seem to possess.

Though the child at this stage neither sees nor hears probably in the true sense of the term, it is not uninfluenced by light and sound. Gradually it gets clear perceptions from all its senses, and then it becomes more than ever a reflex mechanism, its nervous system being responsive to all external things, and its motor system *expressing* this condition. In other words, sensations are streaming in through all the avenues of sense, and these have their outward expression in movements by which, as from the first, the muscular sense on which all exact voluntary movement depends, and the cutaneous sense, the most fundamental of all, and that on which the perfection of all the others depend, are exercised.

At first, sounds though heard can not be localized. Objects are perceived by the eye, but the infant has no idea of their distance. It will reach for a light across the room as readily as if it were but a foot away.

It is clear that the human being at this stage is on a par with

other young animals. Each is a vegetative, reflex, receptive organism. The brain of the infant grows rapidly within the first few months. It no doubt develops equally fast. Already used groups of cells learn to function more perfectly, and new groups take up their duties. Movements become gradually more and more voluntary, more under control, and more definite. Sensory impressions become more and more clearly sensory judgments. To illustrate: The lamp that excited the young infant represents after a few months not merely brightness but an object of definite size and shape, owing to the additions and corrections following from a combined use of the senses. And this process will continue throughout life if not checked.

Both common observation and the closest scientific study have made it plain that youth is the period of sense ascendency. From

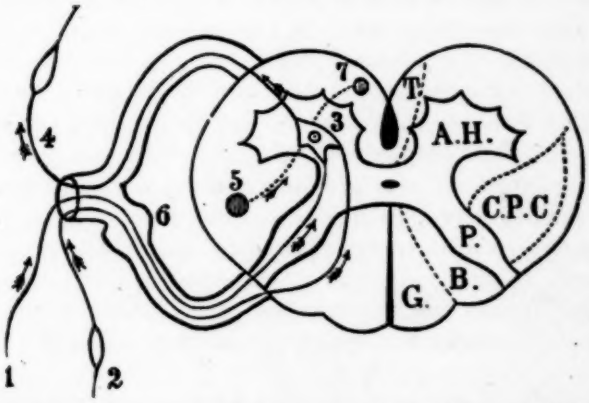

FIG. 4.—DIAGRAMMATIC REPRESENTATION TO ILLUSTRATE THE REFLEX ARC (Bramwell and Ranney). 1, 2, sensory fibers; 3, motor cell of anterior horn; 4, motor fiber connected with 3 and passing out by anterior root of muscle; 5, fiber joining ganglionic cell (3) with crossed pyramidal tract, C. P. C.; 6, ganglion on root of posterior spinal nerve; 7, fiber joining 3 with Türck's column, T. Fiber 2 is represented as passing through Burdach's column to reach the cell, 3.

this, most important conclusions follow, which we can not ignore without paying a heavy penalty. Attention has been called to the infant in order to show that, prior to all school education, Nature asserts herself and points the way in which the human brain and mind develop. Any education that overlooks these facts is directly against the organization we possess, and must be more or less of a failure. How far our methods have been and are in harmony with them I shall presently attempt to show.

For the moment let me follow the child out of the stage of infancy into that of school age. The boy of five, let us suppose, is sent to school a perfect stranger to books and the usual educational equipment. Everything on the road to school attracts him to such an extent that likely enough he may arrive late. When

at school the teacher may find him so restless that the question of keeping him in order so that he shall not disturb others is a matter of serious difficulty. So long as he can be kept in action things go well enough, but to keep this activity within conventional bounds is the problem.

Very often repressive measures that quite paralyze his nature are resorted to in order to adapt his organism to the environment instead of the reverse being attempted. It is forgotten too often that if this young creature were not active, even restless, impulsive, inattentive—i. e., ever ready to secure some new impression—he could not develop after Nature's plan. We are at the outset in possession of some principles by which to test our methods. So far as the soundest physiology and the most recent psychology go, there seems to be but one way to develop this boy's intellect, and that way is along the path that is clearly indicated—the development of the brain and at this period the senses to the fullest extent. Now, as this implies not only seeing, hearing, smelling, and tasting, but feeling in the widest signification of the term—i. e., the muscular as well as the cutaneous sense—we must not only permit of movements but develop them. Smelling and tasting are in human beings of subordinate importance. But vision, to a less degree hearing, and the compound musculo-cutaneous sense, are of vital moment in all sound development.

It is by the development of these senses, together with smell, that the lower animals attain that perfection which in all respects is not equaled by man. But in delicacy and co-ordination of muscular movements, in perfection of visual and auditory discrimination, man is far ahead of the rest of the animal creation. Color-vision and nice discrimination of tones and form are peculiar to man. The painter and the musician have a perfection in the one case of vision and in the other of hearing unknown to any other animal; indeed, only in a feeble measure realized by their fellow-men.

We recognize in the brain of man a *motor area*—i. e., a portion of the surface (cortex) indispensable for voluntary movements of the arm, leg, trunk, indeed for voluntary movements generally.

It is, however, found that if, owing to disease, the path of sensory impressions is interrupted or imperfect, accurate voluntary movements are impossible. A person affected in this way is not only incompetent to do the work of an artisan, but he can not co-ordinate or harmonize his muscular movements to any useful end; so that it is now clear that practically all movements are dependent on sensation; while, again, sensation is much curtailed in essential directions (musculo-cutaneous) if movements be not free, extensive, and accurate.

The development of the motor and sensory areas of the brain are in a measure dependent on each other, and that great region in front, which probably functions in all the higher mental processes, must evidently be hindered in its growth and development if the region back of it is defective. It is impossible to have thought without the material for thought; and this can, so far as all perceptions of *matter* are concerned, be derived chiefly, if not wholly, through the sensory and motor areas working together. This furnishes a physiological basis for the discussion of manual training and all kindred subjects.

These views have received recent confirmation by an examination of the brain of the late celebrated Laura Bridgman, who was defective in all the senses except the tactile and the muscular sense, while absolutely wanting in vision and hearing. Her brain was found much smaller in the sensory areas and its nervous cells few and undersized, owing to disuse, leading to atrophy and failure of development. Experience proves conclusively that all those mental processes on which reflection and judgment depend are in their natural order later of development. Now it is, in my opinion, of great moment to observe in education the natural sequence of development, as any attempt to reverse Nature's order is sure to result in serious harm. We can not bring about in a boy of sixteen a development which should have been begun at five; and this lies at the very root of the question of science in schools, and all others bearing on education. Some have been wondering what all this has to do with science in schools; but I hope to show before I conclude that, according to the homely adage, the longest way around is sometimes the shortest way home.

If my conclusions have thus far been sound, we should be a long way on the road to solving the most important part of any educational problem, viz., the nature of the human brain and mind. The other part of the problem, how best to adapt to the environment, or fit the environment to the mind, is subordinate, though sometimes practically difficult.

It is plain that we must cultivate the senses, and that at the period when they are most susceptible of it, in early youth; that to do this we must not neglect the use of the muscles, or more correctly neuro-muscular activities, for muscular movement of course implies the co-operation of the central nervous system, including the sensory brain areas.

The highest aim of science is to reach great general laws like that which marks the triumph of the science of the nineteenth century, the most important of which is the law of the conservation of energy. But, before any law can be established, a vast number of facts must be gathered. Facts, as regards natural science, mean

phenomena, what is cognizable by the senses and the senses alone. It is hopeless for the most gifted human being to attempt to realize the taste of an apple if he has not had the actual experience. It is idle to read a poem on a sunset to the man that never saw light. We will all admit this; but do we not ignore this very plain conclusion in our teaching? In even the best schools, pure abstractions, or the use of words that can convey no definite meaning because not founded on any sensory experience to the learner, are still too common. Words have but one use—to express knowledge, not to impart it. I greatly wish I could adequately impress this simple truth on those I address, especially the young teachers before me.

How often do we forget that one may have a vast amount of real knowledge of a subject who has never read a page written upon it; while no amount of verbiage can supply those sensory impressions which are essential to all real understanding of the properties of matter! The very first advance the infant makes toward knowledge, real knowledge, is when it first looks out on the world or moves its tiny limbs.

Now, if we would but imitate Nature, or rather assist and not impede her, all would be well. It is a source of great gratification to me that I am in this connection able to refer to one educational method that does almost perfectly realize the true ideal —the kindergarten. The kindergarten was the invention or discovery of a man that got very near to Nature; and had we, led by the light of his genius, but followed, happy would it have been for our education since that time. It is humiliating to think of the long period of stupid blundering through which we have passed. Schools and colleges alike have till recently repressed and dwarfed rather than developed man's intellect in the natural way. It were not possible but that Burns's satire should apply, speaking of colleges, "They went in sturks and came out asses."

Think of what we have passed through! Arithmetic without any basis of concrete perception or practical application; geography, confined to knowing right and left, up and down, in and out, on a flat surface or "map," with certain names attached to these forms that suggested no realities; reading that was necessarily uninteresting and lifeless because the things described were not within the child's experience, and so were not realized; grammar! —that last straw to break the long-suffering learner's back— grammar that was the worst bore of all, because introduced at a period when the mind was unfitted for abstractions and so became divorced from all that was real and practical.

Is it any wonder that farmers and business men complained that such an education was no fitting preparation for real life?

I complain because it was worse. It was a fearful injustice to that noble organization with which we are endowed. The case has improved in a fair proportion of our schools, but we are far, far from the true way still. We are also deluded by the spirit of our age, that aims too much at quantity and too little at quality. In elementary schools especially the culture and the method are, beyond all comparison, of more importance than the facts learned.

Given a youth developing aright, and we find him continuing that natural and happy life he began as an infant. He exercises his senses on the world around him, and is learning under guidance to group his facts—that is, his sensations—and to deduce general laws. This is science, and should be pleasant to every normally constituted human being, and experience proves that such is the case.

The students at our colleges are beginning themselves, after having had a taste of real knowledge, to cry out for more practical work and fewer formal lectures.

You will perceive that the conclusions drawn apply more or less to all studies, even purely literary ones. Literature abounds in descriptions of Nature. These must mean more to him who has actually observed than to the closet student. Much of all poetry, notably such as Scott's, for example, is but feebly realized by those unfamiliar with Nature; to put it otherwise, by those who have not had the sensory impressions essential to realization.

It must now appear that in the true sense education is simply furnishing an environment which is favorable to the development or unfolding the organization of the child. I use the term organization rather than mind because it seems to me that as a human being is a complex, we can never in actual practice consider one part of a child's nature absolutely apart from another. There is no such thing as mental development apart from moral and physical effects; and all experience goes to show that, when any part of the organization of a human being is ignored, the very ends aimed at in any one direction are but imperfectly attained. It has been shown that the infant develops through movements. The boy develops through rambles in the fields or through his games, and the methods are after Nature, though not as perfect when the subject is not under guidance, as he always should be—to an extent not sufficient, however, to interfere with spontaneity. The sooner we get rid of the idea that education is imparting instruction, and that teachers exist to hear lessons, the sooner will we be prepared to enter on the right path.

It has of late years dawned on a few minds that this natural development, which is in a hap-hazard way accomplished by the child in its sports, might be carried out in a systematic way by what is termed manual training, and I allude to the subject in

this address because it seems to me to be in the main so perfectly in harmony with our most recent knowledge in brain physiology and in psychology. Just as the child begins life by investigation with its senses and its muscles, so must this method be followed to the end. This is the scientific method—i. e., it is founded on science. The aimless movements of the infant must be gradually replaced by movements with a definite purpose, and its chance sensations by sensations gathered with a definite object. Rightly understood these objects constitute the *raison d'être* or purpose of manual training, laboratory work, and all kindred methods. It would appear that we can not follow Nature's method without combining muscular movements and the use of the senses. Naturally these develop together, as has already been shown.

What shall we say, then, of educational methods—a fearful abuse of the term—which, instead of permitting of this free and natural development, directly thwart it? In the past the whole development of the child has been sacrificed in no small degree to the three Rs. One might be led to suppose that life was made up of reading, writing, and arithmetic. As a matter of fact, they enter but little into it. Life is made up of feeling, thinking, and acting, which only incidentally involve the three Rs.

The germ or principle of manual training, like that of nearly everything else that is good in education, is found in the kindergarten. All that we have in our modern laboratories, colleges, workshops, etc., exists in that wonderful method.

For a beautiful and successful illustration of the natural method applied in a somewhat different way, I refer you to the January and February numbers of The Popular Science Monthly of the present year.

When once we grasp the true conception of education by realizing that the very object of existence is to attain, as nearly as possible, to a perfect development, which, of course, implies the discharge of all duties and obligations, many problems can be speedily solved in a general way. Much judgment and skill will always be required to accomplish the end in view with the means at hand; or, to put it in a more scientific way, to adapt the organism and the environment to the best advantage. It has been abundantly proved, by the history of education and human affairs as a whole, that with a theory utterly wrong people do not generally fall upon right methods of action; and they never do so when work is to be systematically performed, as in the case of our education in this country for the last thirty years at least. My own elementary education was conducted in what was at that period considered the best school in one of the most progressive cities educationally in this country, yet in the light in which I now see I would have been a great deal better without much of what was

then considered education. I have for a long period been trying to undo the harm wrought and make up for what was omitted at the most impressionable period of life, and I feel to this day that I have not wholly got rid of some of the evil effects. There was not only no science in the course, but the very methods used were radically opposed to science and to such knowledge of our organization as I am endeavoring to show is now well enough established. There was no freedom; the senses were utterly neglected; and human nature could not develop by such methods as were in vogue.

But many will no doubt think the case overdrawn, and point to the fact that development has actually gone on satisfactorily, and that our present standing in science and other subjects is a proof of it. Happily, it is not possible for Nature to be wholly repressed. We develop in spite of bad methods. The boy develops out of school if not in it. The great mass are educated by their work and other associations that make up their every-day life. Some of the best-educated people have never been inside of a school.

The great fertilizing ideas of our age, coming from the mint of genius and embodied in a way that appeals to all and in a measure educates all, have been at work. Who can estimate how great a part such a man as Edison, to mention a single instance, has played in the true education of our period? I purposely now select a practical man rather than a pure scientist. The great difficulty that most teachers would mention, I suppose, in the way of accomplishing their ends is in getting children interested, for children work when they are stimulated by interest. Yet this difficulty is not experienced with the kindergarten method at the beginning, nor in any serious degree with wisely devised laboratory work later at college. Why is a boy more interested in his sports than in his studies? Partly, at all events, because the former are better suited to his nature, to his development, than his studies as sometimes conducted.

Introduce scientific methods, and introduce science itself according to the laws that underlie our organization, and you will revolutionize our schools. To hope for this at once, even if the object were clearly perceived by all immediately concerned in education, would be Utopian; but success comes to those who strive persistently and wisely with a true ideal clearly in view.

I should like it well understood that the same methods that apply to what is usually termed science are also adapted for all other subjects. We use at least some of the same faculties, and it is the same mind that is engaged, whether with literature or science. I have already endeavored to show that one who pursues

literature can not afford to dispense with the early training of the senses.

Having thus cleared the way and erected a platform on which to stand, or, in other words, supplied some tests for all educational methods, the subject of science in schools may be discussed, I hope, intelligently, without dwelling on the subject at great length. As before indicated, the principal questions in regard to science in schools are: When? What? How? How much?

When? As the first step in the knowledge of any branch of science is the gathering of sensory impressions or the noting of phenomena, you will at once infer my answer to this question, which is, as soon as the child begins school life. Of course, then and for some time after, little more can be done than to teach the learner to use its senses and to gather and compare sensory impressions, notably but not exclusively those of vision. This must be continued all through the educational career of the child, for we must ever learn in this way; and the exigencies of practical life constantly demand just such use of our eyes, ears, and hands as is implied in the correct method of studying science.

What? The course of studies proper for school life is a perennial theme of teachers' conventions. But is it not clear that the same end may be attained in many different ways? I do not see that any absolutely rigid course of studies should ever be mapped out, for the simple reason that the whole environment of the child must be taken into account—all the circumstances of the case. Always the most important factor in this environment is the teacher himself.

It is doubtful whether it would be wise to attempt to teach to very young children, with the preparation that most teachers can bring to the work, any branch of science as such; but there is no reason why the school life should not be full of object-lessons. But I mean real object-lessons on those things that have a practical bearing. We accomplish the purpose of education just as well by reference to real every-day life as to objects in which children can have no interest out of school, and which do not and will not make any part of their real world.

At a later age it becomes necessary to decide between, say, botany, zoölogy, physics, and chemistry. But, before referring to these, allow me to put in a plea for a sensible method of teaching geography. It is well to bear in mind that geography really is a science, though what it is in many schools it would be hard to designate by any name. This I do know: it is often very wretched stuff.

Why not introduce a child to geography by taking him into the school-yard or its neighborhood, and there, after rain, making mimic lakes, bays, rivers, etc., or availing of those already made?

Why not get the points of the compass fixed in the natural way by reference to those great guides which alone are of any service to a mariner or explorer? Why not draw a map of the yard, and thus beget some real, tangible notion of the purpose of a map?

As all sciences involve the same methods and employ the same faculties, the choice of one to be studied in any particular case should be determined by such consideration largely as the location of the school, the qualification of the teacher, the extent of the equipment, and perhaps the tastes of the pupils. That branch will produce the best results which is most pleasurably and thoroughly pursued.

All pupils should at some period learn something of physics, though not necessarily mathematical physics. All require some knowledge of the properties of matter as such, and some idea of the forces and mechanism by which the results of industrial life, as well as those of Nature, are accomplished. Practical physics, as illustrated by what is going on around us, and by simple apparatus devised by scholars and teachers, will often serve every purpose. The cost of a chemical equipment depends on the size of the class and the extent of the work. Chemistry is more suitable for more advanced pupils and the better endowed schools.

But of far more importance than all other questions is *How?* We may have a teaching of so-called science that is a mockery of the reality.

It is surely now clear that any mere book teaching is worse than useless. It leads to no real knowledge, can give no healthy training of the faculties, and can lead to no sound development. He who can teach only by the book had better not begin. For pupils just commencing science it is doubtful whether it is not better for a while to avoid the use of text-books altogether. From first to last the student should be an *investigator.* This implies a great deal. It means that he shall desire to know and aim to learn the facts by one method and one only, viz., by seeking for them, as all that have ever found did, by the use of his natural faculties—i. e., by the use of his senses. All that any one can ever really know of any branch of science, let me repeat, is what he acquires by his senses—by feeling, seeing, etc. Whatever subject is pursued, this must ever be kept in mind. The teacher's guidance is invaluable in saving the pupil's time, economizing his energy, assisting in the comparison of results, and aiding in all the higher mental processes that lead to those generalizations which constitute the essence of science. But no teacher can be eyes and hands for any pupil, and to deprive the student of these organs, as all book teaching pure and simple does, is to cut at the very root of all true progress in development.

Nor should the investigating spirit be confined to the school

and school hours. The pupil should be encouraged to observe on his own account and without guidance, and report the results. It is wonderful how much enthusiasm may be aroused in this way. The spirit spreads to the home circle, and the school becomes a quickening leaven to the whole community.

Every class and every school should have its museum. Of all kinds of mere hoarding, museum hoarding is the least objectionable. But the class museum especially should be the receptacle for objects that the pupils bring, thinking them especially suitable to illustrate certain points that have arisen. Sometimes the students prove so enterprising that the teacher's knowledge is severely taxed. But no teacher should be ashamed to admit ignorance. He may assume the attitude of an investigator *with* his pupils; indeed, that is the safest and healthiest way to put the matter. He is then an example of what he would have his pupils become.

It would be well that every school should have a library of books of reference on the subjects of science taught, and indeed on all subjects. The Encyclopædia Britannica is invaluable. Such a use of books as a last resort to aid in settling doubtful points is perfectly legitimate.

If any subject can not be taught by the natural method, that is sufficient to render it unsuitable for any particular class or school.

Physiology and hygiene are of great importance for medicine. All liberally educated people should understand these subjects. No graduate of a college should, in my opinion, obtain his degree without giving evidence of a practical knowledge of the general structure and functions of his own body. No doubt it would be well for the great masses to know the laws of life, and the dangers that beset them from mistakes and excesses. But physiology is perhaps the most difficult of all sciences, certainly the most difficult to teach well in schools. If it be not practical, based on actual observation, it may prove worse than useless. Book physiology is rubbish, utter rubbish. No doubt much useful hygiene may be taught in a practical way, by example rather than by precept; but the attempt to teach scientific physiology to very young pupils can, with few exceptions, end only in failure, and probably in much confusion and misconception. Physiology has been largely introduced into our schools. It would be interesting to know how many of the teachers have themselves a practical knowledge of the subject, and how many of the pupils really understand what they commit to memory. But all teachers, whether required to give instruction on this subject or not, should have a sound, practical knowledge of it, because of its great importance in school life.

There is no science which does not permit of simple experiments that may be introduced into any school. The pupils will delight in these, and they will prove a source of strength, pleasure, and inspiration. I am not, of course, to be understood as claiming that every fact that a child shall take cognizance of shall be gained through observation and experiment; but this is the ideal, and the nearer it is approached the better.

I again repeat that it is not the extent of ground covered, but the method, that is important. Let us not over-examine our pupils. How much in education is sacrificed to examination!

It has often occurred to me that if, in all schools, large and small, there was a certain portion of the time of each week set apart for the development of the general intelligence and moral life of the pupils in such way as the teacher saw fit, irrespective of any rigid course or time-table, it would be well. It should not be difficult to devise safeguards against the abuse of this by unworthy teachers. Readings, talks, short lectures, experiments, excursions, or any means the teacher may devise in harmony with the principles that underlie our organization, will aid in accomplishing the purpose in view. I do not refer to science alone, but to literature, and all that leads to a healthy development. Such a plan wisely put into practice gives tone to the entire school.

There is no limit to the means by which the great aim of education may be accomplished. As I have endeavored to show, the high purpose of education is development according to the laws of Nature as they are unfolded to us by the observations of every-day life, and especially by the study of brain physiology and of psychology. Those methods that harmonize with our organization are successful; all others fail. The child that is educated according to these laws is healthy, happy, and progressive. He leaves school not only uninjured in mind and body, but with the abounding physical and mental vigor that should characterize youth. His tendencies are toward investigation and application. He thirsts to know, and he understands how to enlarge the bounds of his knowledge. He desires to apply, and he can apply. His moral impulses are toward progress, harmony, and freedom of thought and action, and according to his natural endowments does he influence the world more or less, but always for good.

A NUMBER of members of the American Association while in Rochester paid a visit by invitation to the library of the late Lewis H. Morgan. The room, fifty feet by thirty, is finished in oak and black walnut, and is described as a "perfect *thesaurus*" of relics, buckskin suits, ancient weapons, and other objects of interest to the archæologist and anthropologist. Mr. Morgan was chief in one of the tribes of the Iroquois, and his suit of buckskin was shown, packed away as he had left it.

ON POSTURE AND ITS INDICATIONS.

By T. LAUDER-BRUNTON, M. D., F. R. S.

IN a former paper * I observed that I thought medicine lost a great deal by its practitioners either not recording their experience at all, or not recording it in such a form as to be readily available for their fellow-practitioners, or with sufficient precision to be really useful. As examples of vagueness and precision I instanced a verbal description of a face as commonly given, and a sketch containing all the features more or less precisely drawn. In the present paper I have tried in a very imperfect way to indicate the common postures which one meets with daily, either in patients or others, and to discover the reason why those postures are assumed. I have not attempted to draw the figures, for this would have been beyond my powers, and probably also

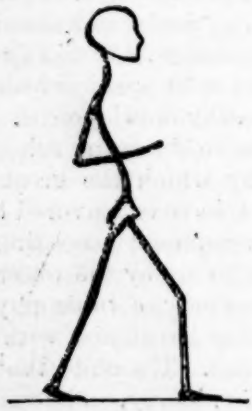

FIG. 1.

FIG. 2.

beyond the powers of many medical men. I have simply indicated the position by a few simple lines such as any one can draw. This method is one which was employed with great success by the late Prof. Goodsir more than thirty years ago in illustrating his lectures on anatomy. In a few lines he conveyed the impression of the agility of the cat as compared with the heavy movements of the ox or of the elephant, and the absence of detail fixed the minds of his students all the more firmly on the main facts which he wished them to carry away. As we walk along the streets and notice the difference of attitude in the passers-by, some with head erect and agile steps convey to us at once the idea of energy and activity (Fig. 1), while others with hanging heads and bended knees suggest the ideas of languor, weakness, and depression (Fig.

* On the Method of Zadig in Medicine. The Lancet, January 2, 1892.

2). It is a matter of ancient observation that such an attitude as this is associated with weak circulation, and it is probably more than three thousand years ago that the injunction was given: "Strengthen ye the weak hands and confirm the feeble knees; say to them that are of a fearful heart, Be strong, fear not" (Is. xxxv,

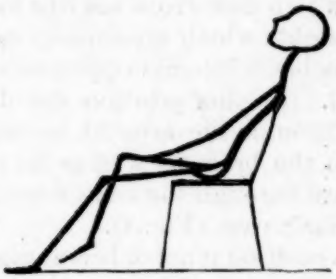

FIG. 3.

FIG. 4.

3, 4).* When the heart is stimulated by joy or hope, the attitude again becomes erect, and the gait brisk and elastic. It is by no means easy to distinguish exactly between the part played in this change by the motor cells of the nerve-centers and by the circulatory apparatus, for the activity of the motor cells on which muscular action depends is itself influenced to an enormous extent by the circulation of blood through the nerve-centers. We find an example of this in the attitude unconsciously assumed by any one engaged in conversation or argument. So long as he takes only a listless interest in the subject under discussion he may lie back

FIG. 5.

FIG. 6.

in the chair with his legs crossed and his arms either hanging down or his hands laid loosely in his lap (Fig. 3). As his interest increases his attitude becomes more erect (Fig. 4), and he sits straight up, with his hands folded or laid upon his knees instead

* Also, "Lift up the hands which hang down, and the feeble knees, and make straight paths for your feet" (Heb. xii, 12).

of hanging listlessly down (Fig. 5). As the interest increases still further the body is bent forward at an angle and the hand is very probably placed firmly on the thigh (Fig. 6). If he becomes excited in the heat of argument, the body is bent forward at a somewhat acute angle and the hand is stretched out in front and somewhat upward, as if to help the words which flow from his lips to drive the thoughts which are rapidly evolved from his brain into his opponent's mind (Fig. 7). In this position the flow of blood through the arterial system onward to the brain as well as its return backward through the veins seems to be particularly easy (Fig. 8).

FIG. 7.

This position is not only assumed during the heat of argument whether the speaker be sitting or standing, but when one is led to assume it unconsciously it seems to give rise to a rapid and sometimes almost uncontrollable flow of ideas. Thus it occasionally becomes a cause of remorse to devout souls, who during the attempt to pray in church in this attitude are sadly distracted by crowds of ideas which at once disappear on the assumption of an easy sitting posture. The circulation in the cerebral vessels and the current of ideas in the brain are very delicate things and may be modified by very slight causes; thus, an attitude with the head drooping slightly more than that indicated in Fig. 6, and with the chin supported upon the hand, is the one frequently assumed in deep thought, with concentration of ideas upon a single subject, and no desire for immediate expression (Fig. 9). The touch of

FIG. 8.—TRACING FROM THE BRAIN. A, in upright position; B, with head inclined forward.

the hand upon the head seems to have a directing power over the thoughts which one would formerly have been inclined to deny, but such experiments as those of Tesla and Crookes with electric currents of very high tension give a visible illustration of phenomena previously unknown and seemingly incredible. For in these experiments a person who has put himself into the electric field renders vacuum tubes containing various substances fluorescent, and fills them with a glow of colored light by simply wav-

ing his hands over them. The tubes, which were previously dark, owe their luminosity only to the approximation of his hand, yet he himself does not feel that any special power has gone out of him. The contact of the hand with the temples seems as if it could hardly by any possibility modify the circulation in the brain or the feelings of the individual, and yet it appears to have

FIG. 9.

FIG. 10.

an actually soothing effect and to be a real physical solace in cases of grief and depression (Fig. 10). At the same time the greater droop of the head possibly provides for a better supply of blood to the sensory parts of the brain in the posterior part of the head, and thus to a certain extent counteracts the general weakness of the circulation. In the case of excitement (Fig. 7), the head being more raised, if a straight line were drawn through the axis of the body so as to represent the line of the aorta and carotid arteries, it would come out at the anterior part of the head, and blood driven onward in this line would supply nutriment rather to the motor than to the sensory centers.

In cases where the circulation is exceedingly weak and syncope is threatened, a most useful plan is to make the patient put his head down between his knees (Fig. 11), so that an ample supply of blood shall reach the cerebral centers. Long ago, before the introduction of anæsthetics, a common plan of rendering patients senseless previously to the performance of an operation was to lay the patient flat upon his back and then suddenly hoist him to a standing posture by six strong men who held him by the arms, three on one side, and three on the other. The brain being thus, as it were, lifted away from the blood, became so anæmic that it ceased to act before the circulation could adapt itself to the new posture.

FIG. 11.

An experience of my own once showed me how very dependent the brain is upon the supply of blood. I was called upon one night after a long day's work to write an article immediately. I

sat down with pen, ink, and paper before me, but not a single idea came into my head, not a single word could I write. Lying back, I soliloquized: "The brain is the same as it was yesterday, and it worked then; why will it not work to-day?" Then it occurred to me that the day before I was not so tired, and probably the circulation was a little brisker than to-day. I next thought of the various experiments on the connection between cerebral circulation and mental activity, and I concluded that if the blood would not come to the brain the best thing would be to bring the brain down to the blood. I laid my head flat upon the table, and at once my ideas began to flow and my pen began to run across the paper. I thought, "I am getting on so well, I may sit up now," but the moment I raised the head my mind became an utter blank, so I put my head down again flat upon the table and finished my article in that position.

Stimulation of some branch or other of the fifth nerve seems to increase the circulation in the brain, and those who are making their utmost calls upon their mental powers are accustomed to stimulate this nerve in one way or another. The late Lord Derby used to eat brandied cherries, and an experiment of Marey's (Fig. 12) proves that mastication will accelerate the flow of blood through the carotid artery, and serves to show the wisdom of an editor whom I knew who used to eat figs while writing a leading article, and even of those who indulge in the practice so disagreeable to their neighbors of chewing tobacco. Others stimulate the gustatory branches of the fifth nerve by the sweets which they suck, or by the smoke of a cigar or cigarette, while a rustic called upon suddenly to answer a question will probably excite the cutaneous branches of this nerve by scratching his head, and a man of more culture may stroke his mustache or beard, press his forehead or eyes, or, like many Germans, smite his nose with the forefinger.

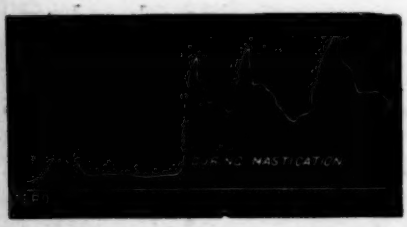

FIG. 12.—TRACING OF THE RATE OF CIRCULATION IN THE CAROTID. (After Marey.)

A similar reason may be given to explain the habit of snuffing, formerly so much in vogue. The gentle titillation of the nasal mucous membrane by the snuff probably serves to stimulate the cerebral circulation, and the increased arterial tension due to the efforts of sneezing so increases the cerebral nutrition that difficulties seem at once to disappear, and obscurities of mental vision are so rapidly removed that snuff is said in popular language to "clear the head." The practice of snuffing has fallen to a great extent into disuse, but it may still be occasionally employed with

advantage in cases of severe and persistent headache, where other remedies fail to relieve. Even where such a strong irritant as snuff is not resorted to, smelling salts (sal volatile) or aromatic vinegar may give considerable relief in headache if frequently inhaled.

While stimulation of the fifth nerve as just described tends to keep people awake and increase their mental activity, gentle, rhythmical stroking of the head tends, on the contrary, to make them fall asleep, and brushing the hair has this effect on many people to such an extent that the movements of the hair-dresser's fingers over the scalp, and rhythmical click of the shears, will

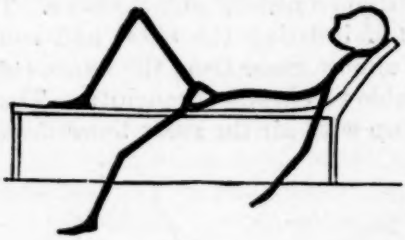

FIG. 13.

FIG. 14.

send some people to sleep, even at the risk of having their hair shorn to a much greater extent than would be at all pleasing to them on awakening. A gentle rubbing of the scalp, as if to loosen it upon the skull, also tends not only to soothe irritability, but to relieve and to prevent headaches.

External temperature has a powerful effect in determining posture. On a hot summer's day the natural tendency is to lie down with the head slightly raised, the arms hanging loose, and one leg extended, while the other perhaps is drawn up, as in Fig. 13. The physiological reason for this posture is that in it the greatest extent of cooling is attained, for it insures the greatest possible exposure of the largest vascular district in the body—viz., the intestinal vessels—to the cooling influence of the external air. This is aided by the loss of heat due to the evaporation of sweat. By the slight raising of the head and the drawing up of one leg, the abdominal parietes are rendered loose, and the intestines tend to fall sideways, and the abdomen tends to become flattened from before backward. The greatest extent of cooling surface is thus obtained, and the temperature of the body is kept as low as possible.

An entirely opposite attitude is assumed when the external air is cold (Fig. 14). The thin abdominal walls being insufficient to protect the intestinal vessels from the cooling influence of the external air, the legs are drawn up until the thick muscles of the thigh form a warm covering to the abdomen and thus prevent

loss of heat from the intestinal vessels. Many people are unable to get to sleep when they are at all cold; and Rosenthal has shown that this attitude is commonly adopted by men, dogs, and other animals when preparing to sleep, so as not only to maintain the bodily temperature during sleep, but to allow the intestinal vessels to dilate and accommodate a mass of blood which would otherwise be driven into the cerebral circulation, stimulating it to functional activity and keeping the person or animal awake.

The attitude of the body may be altered permanently by occupation or disease in such a way that one accustomed to pay attention to this subject can frequently make out, with a little trouble, a good deal regarding the patient's history and illnesses. Thus, a chronic cough has the effect of inflating the chest and rounding the back, so that one might almost guess from the figure (15) that the person so shaped was liable to chronic bronchitis. The more tightly a bladder is blown up with air the more tense does it be-

FIG 15.

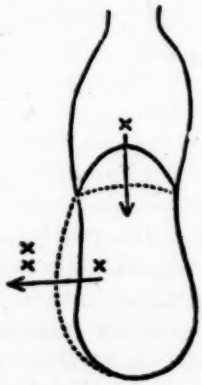

FIG. 16.

come and the more does it take a circular form. In the same way the more an alveolus of the lung is blown up by the efforts of coughing the more does it resemble the inflated bladder. What is true of a single alveolus is true of the chest as a whole. It tends as nearly as possible to become globular, with a circular outline not only in the transverse but in the longitudinal direction. The sternum and vertebræ prevent it from becoming completely globular, notwithstanding all efforts, and it thus assumes the barrel shape so characteristic of emphysema, as being the nearest possible approach to a globe. In going through a hospital ward one sees here and there patients who are constantly sitting up in bed and do not lie down at all; these are for the most part people who have great difficulty of breathing. The reason for this position has no doubt been often given, but I do not recollect coming across it in print and I can not say whether

the reason that I now give has been evolved from my own brain or whether I have learned it from others.

When a man is sitting upright the diaphragm moves up and down during respiration (Fig. 16). At each inspiration it descends and displaces the intestines and the abdominal walls outward. During each expiration the diaphragm ascends and the intestines and abdominal wall return back to their former position. In the upright posture the diaphragm moves vertically, but the abdominal walls and intestines move in a horizontal plane and there is no lifting work for the diaphragm to do. The case is quite different when a man is lying on his back, for then the diaphragm moves in a horizontal plane and the abdominal walls and intestines in a vertical one. During inspiration as the diaphragm encroaches on the abdomen for the purpose of enlarging the thorax (Fig. 17) it has actually to raise the intestines and the abdominal walls instead of merely moving them in a horizontal plane. As the diaphragm returns into the thorax during inspiration its progress will be accelerated by the weight of the descending intestines, and thus the recumbent posture may be sometimes useful in cases of bronchitis with emphysema, and so such cases may be seen sometimes lying down although there is considerable interference with the aëration of the blood. In cases of cardiac disease no benefit of this kind is obtained, and therefore we find that a large proportion of those whom we see sitting upright in bed in a hospital ward are suffering from disease of the heart.

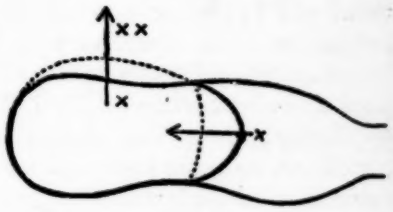

FIG. 17.

When a patient lies upon his side the intestines also move in a horizontal plane, and this is the position usually assumed during healthy sleep, for in it there is no interference with expiration any more than when the patient is sitting upright, while at the same time the rest obtained is much more complete. The side upon which one lies is immaterial to most healthy persons, and they frequently lie first upon one and then on another, turning over perhaps several times in the course of the night; but in cardiac disease or cardiac irritability without organic disease patients frequently are unable to lie upon the left side because the heart beats against the ribs with such force as to cause physical discomfort. At the same time the heart itself appears to be stimulated by the blows which it gives itself against the thoracic walls and to palpitate more violently than before. The patient is therefore obliged to lie upon the right side. A similar result

may occur if the liver is enlarged or congested, for then it seems to drag upon the suspensory ligaments when the patient lies upon the left side, and thus he is obliged to turn round that the liver may be supported by the ribs. If a heavy meal has been taken shortly before retiring to rest the person may be unable to lie upon his left side because the stomach drags upon its pyloric end. On the other hand, if the stomach is distended by flatulence, the gases sometimes will not escape while the patient is lying on his right side, and he must either be raised into a sitting posture or be turned on his left side to allow the gas to eructate by the œsophagus and the tension in the stomach to be relieved,* for the œsophagus joins the stomach at such an angle that when the patient is on his right side the gases appear to accumulate and not to find an exit through the œsophagus, but when he is on his left side they pass upward with comparative ease. This, of course, is a matter of very slight moment to patients who are able to move readily, because they adjust their own position at will and soon find out which is the most easy one for them. But when a patient is so weak that he is unable to move himself he is frequently allowed to lie flat on his back and to suffer much from abdominal distention and even from difficulty of breathing, due to the diaphragm being pushed upward, when he might be relieved by simply sitting him up for a few minutes or turning him over on his left side.

In this short paper I have made no reference to many other postures in disease, neither have I attempted to discuss the postures due to trade, nor have I attempted to make the paper complete. I have merely tried to give an illustration of an easy method of recording posture in a tolerably precise and easily understood way, and have attempted to connect external signs with physiological conditions as an illustration of the method of tracking which I mentioned in a former paper in the hope of inducing others to prosecute the same line of work.—*London Lancet.*

FORECASTING the future of psychology, Prof. Charles Richet anticipates, with regard to comparative psychology, that we may some day arrive at the reason of madness and crime, with all the important social solutions which that knowledge would carry with it. With regard to transcendental psychology, we possess, he said, numerous gifts often or almost always imperfect, which allow the supposition that human nature has extraordinary resources, and that it contains forces which it does not even suspect. The author hoped the day would come when all these scattered gifts would be realized.

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* I have found this practice useful. The explanation I have given of its utility was, I think, suggested to me several years ago by John Haddon, M. A., M. D.

THE PROBLEMS OF COMPARATIVE PSYCHOLOGY.*

By JOSEPH JASTROW, Ph. D.,
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TO any one thoroughly impressed with the intimate relations of mind and body, it seems natural enough that the gradual development and perfection of the one should carry with it analogous stages in the growth of the other; but even the most profound student must at times give wondering expression to the marvelous extent, the endless variety, and the unexpected precision of the interrelations of the physical and the psychological. An extensive survey of the phenomena to be studied, and a discerning and comprehensive use of the comparative method in studying them, are as necessary and as promising in the mental as they have proved to be in the physical sciences. We must overcome the tendency to study too exclusively our own adult, civilized, conscious selves; to view the landscape by observing its reflection in a mirror, and thus seeing everywhere our own image. With full appreciation of the supreme interest we must always have in our own mental powers, it may be maintained that in proportion to our knowledge of the earlier, simpler, and lowlier manifestations of intelligence, will be our ability to appreciate and utilize the best and worthiest faculties in ourselves.

Comparative Psychology finds its origin and its material in the variety of animal life, in the series of changes of which an individual life consists, and in the evolution of more complex forms of life from one generation to another. The first of these—Animal Psychology—endeavors to arrange in orderly sequence the various forms of mentality from protozoon to man, to discover in what this advance consists, to establish orderly relations between mental powers and the nervous system, and the like. The study of the stages, and especially the earlier stages, of the growth of the human mind—Child Psychology—has only recently been pursued in a scientific spirit, so that systematic records of the essential and important points of child-growth are lamentably rare. But even this limited research has brought to light an interesting body of facts, and holds out the promise of more valuable results as the fruits of more extended investigation. The side of anthropology that deals with the stages of man's mental progress from rudest savagery to the highest civilization; tracing the variety and onward movements of customs, habits of thought,

* Abstract of a lecture delivered before the Chicago Institute of Arts, Science, Letters, and Religion.

and beliefs; showing the effect of environment upon mental constitution, and in endless ways contributing to the natural history of human endeavor—all this abundant material has been ably canvassed, but needs to be rearranged upon a psychological basis to form the science of Anthropological Psychology.

It is so obviously impossible within the present limits to consider the facts and generalizations of these departments of science, that no justification is necessary for confining our attention to some consideration of the relations of these three paths of development to one another, and particularly to the psychological position of man. In so doing excursions into each of the fields will be made, and some glimpses be obtained of the several departments of Comparative Psychology.

To appreciate the comparison of infant with animal traits, one must bear in mind some important characteristics differentiating the young of the human kind from the young of other animals. The series of changes of which an individual life consists indicate that the individual enters life in a condition simpler than that which it eventually attains. These changes diminish in extent as we descend the scale of organisms, until in the lowest organisms the newly born and the adult are almost indistinguishable. Whether we consider the embryonic preparatory stage of life, or whether we regard as the beginning of existence the entrance to the environment of Nature, and speak of the preparatory stage as that which intervenes between birth and maturity, we shall find it measurably true that in proportion to the complexity of mental development to which the individual may eventually attain will this pre-adult period be lengthened. An aspect of this law, of special psychological interest, is the resulting difference in the powers present in the newly born of different species: the lower organism has a larger share of its powers ready at birth, has less to learn, less to be modified by and adapted to its environment than has the higher organism. Many of the marvelous instincts characteristic of the insect tribe seem to be at the service of the new-born individual. "With such creatures as the codfish, the turtle, or the fly-catcher, there is . . . nothing that can be called infancy" (Fiske). The most complete experiments bearing upon this point are those of Mr. Spalding. In the first minutes of life chickens follow "with their eyes the movements of crawling insects, turning their heads with the precision of an old fowl. In from two to fifteen minutes they pecked at some speck or insect, showing not merely an instinctive perception of distance, but an original ability to judge, to measure distance, with something like infallible accuracy." A chicken hooded as it emerged from the shell was unhooded when three days old; six minutes later "it

followed with its head and eyes the movements of a fly twelve inches distant; and about ten minutes later "made a vigorous dart at the fly, . . . seized and swallowed it at the first stroke." When placed within sight and call of a hen, "it started off toward the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after-life. . . . This, let it be remembered, was the first time it had ever walked by sight." The young of mammals, though not as independent as chicks, show quite a remarkable series of powers ready at birth. A pig in one of Mr. Spalding's experiments, blindfolded at birth, went about freely, though stumbling against things. When the blinder was removed the next day, it "went round and round as if it had had sight and suddenly lost it. In ten minutes it was scarcely distinguishable from one that had had sight all along." And Mr. Fiske tells us that "all mammals and most birds have thus a period of babyhood that is not very long, but is, on the whole, longest with the most intelligent creatures. It is especially long with the higher monkeys, and among the man-like apes it becomes so long as to be strikingly suggestive." Mr. Wallace observed an orang-outang three months old, perfectly helpless, unable to feed or walk without assistance, or to grasp objects well, and of these creatures Mr. Huxley says that they "remain unusually long under their mother's protection," and are probably not adult until ten or fifteen years old.

The extreme divergence between the state in which the individual enters the world and the powers attainable during life appears without question in the human species. A more complete condition of helplessness than appears in the human infant can scarcely be conceived: only such senses and movements as are immediately necessary to nutrition are present; although sensitiveness to light, and after some days to sound also, appear, accurate perception by these senses is impossible for several months. While the newly hatched chick sees a grain of corn and accurately seizes it, the human infant in the presence of a desired object, even after months of practice, performs a host of uncoördinated, useless movements, obtaining the object as much by accident as by design. On the other hand, we should not forget the marked educability of the higher animals. An old bird does and avoids much that is impossible to the young one; the kitten and cat, the pup and dog, show still greater differences. As a single illustration from the vast testimony on this point, Dr. Eimer's observations with a trap for catching sparrows may be cited. At the first setting he caught a dozen sparrows; at the second setting, nine were caught; but all these "were young birds, hatched the same spring, and therefore of little experience. Not a single old sparrow had entered the trap." The following spring "a curious spectacle

was observed: apparently several sparrows had the desire and the intention to go into the trap, and these were obviously the young, inexperienced birds which had been hatched since the trap was last set"; but the older birds sounded the cry of warning, and kept the venturesome young sparrows away.

Let us next view the prolongation of human infancy in the light of the law of habit. This law declares that every reaction of an organism to a condition in its environment renders the repetition of that reaction quicker, easier, more certain, more uniform; and the existence of habits implies an environment sufficiently constant to repeatedly present to the organism the same or closely similar conditions. Mere existence in a world so full of regularities, of rhythm and law, of recurrences of the same needs, results in the performance of definite actions in definite ways; and it equally results that the earliest experiences will produce the strongest impressions and will gradually render more difficult the learning of other modes of reaction, even though these others, owing to a change of conditions, would be more useful. Accepting the power of adaptation to an extensive and variable environment as *an* if not *the* index of a high intelligence, it follows that prolongation of the period during which acquisition is possible and easy will greatly further intellectual progress. The supreme significance of education thus appears as an outcome of the long preparatory period of human life; the modifiability of the individual is what makes possible training, education, alike in animals and men, and modifiability involves immaturity. Man attains his high intellectual position by entering the world the most helpless of living kind; but, because less freighted with the ingrained habits of his ancestors, is he freer to develop habits of his own. "It is babyhood," says Mr. Fiske, "that has made man what he is."

Pursuing our thought in another direction, we find that organisms entering life more nearly mature will be more like one another, will present fewer individual differences than animals with extended periods of immaturity; and in turn one generation will be more like the preceding and the progress of the species be proportionately slow. The early independence of the young involves action upon inherited instincts, which naturally are closely the same for all members of the species; there thus results a fundamental similarity, leaving a relatively small margin for individual differences. A further result of a prolonged infancy is the group of emotions it arouses and perpetuates on the part of the parents. Motherly devotion and affection, fatherly interest and supervision extend over a larger and longer period as the species is more and more highly developed, until among the highest races of man it continues in a modified form throughout life, and in this modified

form contributes to the development of the sentiments of kinship, family pride, altruism, and many social virtues. We thus have reason to connect education, family government, together with the rich emotional capabilities, the complex intellectual powers that follow in their train, with the apparently insignificant fact that the human infant enters life in a much less mature condition than the young of other species.

We have thus far been occupied in comparing stages of animal with stages of human development; we shall now test the validity of the same train of thought in the comparison of different stages of human progress. It would appear that among less civilized peoples there is a shortening of the pre-adult period, a precocity of development, an earlier abandonment by the parent, an earlier independence of the young. Mr. Spencer tells us that in equatorial Africa the children are described as "absurdly precocious," that among the west Africans the youth are "remarkably sharp when under puberty—that epoch, as among the Hindus, seeming to addle their brains." An interesting result of this difference is the early wane of the powers of receiving new ideas, and the consequent limitations of the mental horizon. The civilized mind at first lags behind the uncivilized, but the latter soon comes nearly to a standstill, and is then immeasurably outstripped by the continued growth of the former. Thus—still drawing upon Mr. Spencer's facts—of the Australians it is said that "after twenty their mental vigor seems to decline, and at the age of forty seems nearly extinct"; of the Sandwich-Islanders, "that in all the early parts of their education they are exceedingly quick, but not in the higher branches; that they have excellent memories, and learn by rote with wonderful rapidity, but will not exercise their thinking faculties"; of New-Zealanders, that "at ten years of age [they] are more intelligent than English boys, but as a rule few New-Zealanders could be taught to equal Englishmen in their highest faculties." Sir Samuel Baker says of the negro in Africa, that in childhood he is in advance in intellectual quickness of the white child of the same age, "but the mind does not expand—it promises fruit, but does not ripen"; and the educators of the negro in this country have encountered similar difficulties—great aptitude at beginnings, but inability to go on to original thinking.

The comparison regarding the uniformity of minds whose period of development is relatively brief will apply to widely differing human races. There can be little doubt that primitive people are more like one another than are individuals belonging to a higher mental type, and in the different classes of a civilized community there is greater individuality among the educated than among the uneducated, and this can hardly be unrelated to the postponement of independence, the longer education, which the

former enjoy. This similarity of individuals in relatively low stages of development is accompanied by a lack of mental pliability, a rigidity of custom, thought, and habit, that in turn leads to the perpetuation of meaningless customs, to an unyielding conservatism, an uncertain and fitful advance. And we may add that the development of the parental feelings and virtues seems clearly richer in highly developed races than in undeveloped ones. We may epitomize our thought in Mr. Spencer's words: "The animal kingdom at large yields us reasons for associating an inferior and more rapidly completed mental type with a relatively automatic nature. Lowly organized creatures guided almost entirely by reflex actions, are in but small degrees changeable by individual experiences. . . . Inferior and superior races are contrasted in this respect. Many travelers comment on the unchangeable habits of savages. The semi-civilized nations of the East, past and present, were or are characterized by a greater rigidity of custom than characterizes the more civilized nations of the West. . . . And if we contrast classes or individuals around us, we see that the most developed in mind are the most plastic."

I have dwelt long upon this argument because it illustrates so well the closely analogous developments of these three paths of mental unfoldment, inferences traceable from facts gathered along one of the lines finding corroboration along the others, and all contributing to the significance of the dictum that the child repeats *in parvo* the history of the descent of man, and of the growth of the human race.

Resuming at this point our comparison of animal with infant traits, we have learned to expect mental similarity only in such animals as in their adult condition surpass at least in certain respects the capabilities of the human infant at birth. Within this range we find abundant points of community of various degrees of value and familiarity. The playfulness that is characteristic of children is no less so of kittens, nor is their imitativeness more typical than that from which the word "to ape" has been derived. Curiosity, inventiveness, dislike of ridicule, love of being fondled, craving for attention, with the resulting jealousy and anger when such attention is refused, are types of more complex emotions common to intelligent animals and children. Indeed, the terms of familiarity so often found and so easily established between children and their pets can not but be based, in part at least, upon a deep sympathy and community of emotional life. On the intellectual side correspondences are no less frequent and significant, but are difficult to describe and analyze. M. Perez, a discerning student of children, has carefully recorded the life histories and early trials of two pet kittens, and found constant occasion to draw analogies between the kittens and the

infants. Both show at parallel stages of development the appearance of the same faculties, often in strikingly similar forms. Just as infants learn to distinguish between men and women, between persons differently dressed, between old and young, kindred and stranger, so an intelligent dog learns to distinguish between visitors and beggars, between strangers and friends of the family, between those who will fondle him and those who will not. A single illustration is all we can stop to recount. A child was accustomed to hear prayers read by the head of the household, who while thus engaged often rested his head on his hand. When asked to say prayers, the child assumed this at first inexplicable attitude and mumbled something under its breath. The real process was incomprehensible, the outward form had been mimicked and some insignificant detail seized upon as the essential. Precisely the same is true of the behavior of the monkey described by Dr. Romanes. This pet animal was given the key of a trunk in which nuts were kept, and "every time he put the key into the lock and failed to open the trunk he passed the key round and round the outside of the lock several times. The explanation of this is that my mother's sight being bad, she often misses the lock when putting in the key, and then feels round and round the lock with the key; the monkey therefore evidently seems to think that this feeling round and round the lock with the key is in some way necessary to the success of unlocking the lock, so that, although he could see perfectly well how to put in the key straight himself, he went through the useless operation first." Not alone can this general parallelism between infant and animal traits be maintained, but to a considerable extent can it be shown that the powers and traits appearing earliest in the child are those already present in the lower groups of animals; and Dr. Romanes has drawn up a table exhibiting the first appearance of various emotions and intellectual powers in the animal scale and in the life history of human individuals, in which he makes the order very largely the same for both.

We may now proceed to illustrate the relation between child psychology and anthropological psychology, to trace points of community between the infancy of the race and the infancy of the individual. At the stage at which, owing largely to the development of language, the analogies between infant and animal traits become weak and scanty, the comparison between the child and the savage increases in extent and importance. Difficult as it is to select typical instances of this varied and suggestive similarity, both in emotional and intellectual traits, yet the attempt must be made. In the emotional sphere we would instance instability of character, impulsiveness, an easy and quick transition from one series of emotions to their opposites, violent passion upon

slight provocation, with an equally intense pleasure in trifles, a great joy in brilliant and startling sense-impressions, a narrow range of susceptibilities, with the self-centering emotions—especially fear, anger, jealousy, vanity—the more prominent. The instability of the child's character hardly needs illustration; it depends largely on the limited range of memory and rational expectation. A child in pain is appeased by a sugar-plum; its anger forgotten in a new picture-book. The entire attention is given to one object; this fills the mental horizon, much as the hypnotized subject attends solely to the suggestion of the operator. Passionateness is a typically childish trait; at two months the characteristic pushing away of distasteful objects, screaming, growing red in the face, appear and continue with increasing vehemence until a wise surrounding gradually substitutes for them a more rational procedure. Of childlike traits in savages there are abundant illustrations. The Snake Indian is termed "a mere child, irritated by and pleased with a trifle." Of the tribes of the Malayan Peninsula it is said that "like children their actions seem to be rarely guided by reflection, and they almost always act impulsively." The tears of the South Sea islanders, "like those of children, were always ready to express any passion that was strongly excited, and like those of children they also appeared to be forgotten as soon as shed." Accompanying this there is "a childish mirthfulness—merriment not sobered by thought of what is coming." Mr. Spencer thus comments upon these facts: "The saying that a savage has the mind of a child with the passions of a man (or, as it would be more correctly put, has adult passions which act in a childish manner) thus possesses a deeper meaning than appears. There is a genetic relationship between the two natures, such that, allowing for differences of kind and degree in their emotions, we may regard the co-ordination of them in the child as fairly representing the co-ordination in the primitive mind."

Similarities in intellectual traits lie close at hand; the study of language offers a number of pertinent illustrations. The prominence of gesture, pantomime, facial and other expressions in the primitive speech has been conclusively established, and is equally typical of the child's language at certain stages of its development. In both, speech partakes less of symbolism and has a natural directness of meaning. When we are told that the Bojesmans can not converse at night without a fire, because their language is dependent upon explanatory gestures; that the language of a Ceylon tribe is composed largely of signs, grimaces, and guttural sounds; or that the Tasmanians observe no settled order or arrangement of words in their sentences, we are at once reminded of like characteristics in a child's babbling. Similari-

ties in linguistic details may also be observed. Primitive languages abound in reduplicative words, as is shown in many words that we have adopted from them, such as *cocoa, anana, agar-agar, pow-wow;* and Sir John Lubbock has found from twenty to eighty times as many such reduplications in savage as in European tongues. Children are constantly using reduplications, some of which we have adopted from their baby talk; such as *papa, mamma,* the German *amme, pupe,* the French *bébé.* The imitative faculty, a marked characteristic of savages and children, appears in language in the many words founded upon direct imitation or sound analogy. The child speaks of the *mu-mu,* the *bow-wow,* the *tick-tack,* the *shu-shu,* the *ting-a-ling;* and the large proportion of onomatopoetic words in savage tongues is well recognized. Difficulty in pronouncing certain sounds, inaccuracy of articulation, a mention of only the prominent words without definite order and connection, a mere skeletonizing of the sentence—these and the like are found both in the infancy of language and in the infant's language.*

The characteristics of language are often indicative of the mental traits of those who use it. The child's word sphere is at first concrete and specific, acquiring but very gradually a use of ideas and words that are generic and abstract. These are equally the limitations of the savage mind; the absence of generic and abstract words in savage tongues has been noted by various travelers. Some Brazilian tribes have "separate names for the different parts of the body, and for all the different animals and plants with which they were acquainted, but were entirely deficient in such terms as 'color,' 'tone,' 'sex,' 'genus,' 'spirit,'" etc. The language of the Veddahs (Ceylon) is said to be so primitive "that the most ordinary objects and actions of life are described by quaint paraphrases." Some of the Indian tongues have words for red oak, white oak, etc., but not for oak or for tree. Other evidence of the mental poverty is easily supplied. "The mind of the savage," says Sir John Lubbock, "like that of the child, is easily fatigued, and will then give random answers to spare himself the trouble of thought." Mr. Galton says of the Damaras that they never generalize, and "a Damara who knew the road perfectly from A to B, and again from B to C, would have no idea of a straight cut from A to C; he has no map of the country in his mind, but an infinity of local details."

The savage and childish conceptions of quantity, number, time, and space show striking similarities of limitation and de-

* The study of the natural language of the deaf-mutes yields important corroborations of many points. This has been ably studied by Mr. Tylor in his essays on Gesture Language, in Early History of Mankind; see especially page 54.

fect. There seems to be considerable evidence that very primitive peoples do not count above four or five, all quantity above that being simply an indefinite many. Mr. Galton has given so striking and graphic an account of a Damara's conflict with matters mathematical, that one can not forbear citing it in detail: "In practice, whatever they may possess in their language, they certainly use no numeral greater than three. When they wish to express four, they take to their fingers, which are to them as formidable instruments of calculation as a sliding rule is to an English school-boy. They puzzle very much after five, because no spare hand remains to grasp and secure the fingers that are required for units. Yet they seldom lose oxen; the way in which they discover the loss of one is not by the number of the herd being diminished, but by the absence of a face they know. When bartering is going on each sheep must be paid for separately. Thus, suppose two sticks of tobacco to be the rate of exchange for one sheep, it would sorely puzzle a Damara to take two sheep and give him four sticks. I have done so, and seen a man put two of the sticks apart, and take a sight over them at one of the sheep he was about to sell. Having satisfied himself that one was honestly paid for, and finding to his surprise that exactly two sticks remained in hand to settle the account for the other sheep, he would be afflicted with doubts; the transaction seemed to come out too 'pat' to be correct, and he would refer back to the first couple of sticks; and then his mind got hazy and confused, and wandered from one sheep to the other, and he broke off the transaction until two sticks were put into his hand and one sheep driven away, and then the other two sticks given him, and the second sheep driven away. . . .

"Once while I watched a Damara floundering hopelessly in a calculation on one side of me, I observed Dinah, my spaniel, equally embarrassed on the other. She was overlooking half a dozen of her new-born puppies which had been removed two or three times from her, and her anxiety was excessive as she tried to find out if they were all present, or if any were still missing. She kept puzzling and running her eyes over them backward and forward, but could not satisfy herself. She evidently had a vague notion of counting, but the figure was too large for her brain. Taking the two as they stood, dog and Damara, the comparison reflected no great honor on the man."

Of corresponding difficulties in children it would doubtless be possible to collect considerable evidence. Prof. Preyer, in his painstaking study of his infant son, found that the child would miss one of his set of nine-pins when ten months old, but so late as the twenty-seventh month he failed to teach the child the difference between numbers from one to five; and two months later

three matches were not distinguished from four matches, and "too much" and "too little" were confounded in the same way as "five and two." Children's notions of time are equally defective. M. Perez mentions a child describing a year as "many, many, many to-morrows," which expression is doubtless as exact as the underlying idea. The same child could not be taught the difference between "yesterday" and "the day before yesterday." In a statistical research it was found that, of children ready to begin their school life, eight per cent did not comprehend the meaning of *three*, seventeen per cent of *four*, and twenty-eight per cent of *five*.

The similarities between the mental processes of child and savage are far from being exhausted by this sketchy enumeration; it may indeed be maintained that the most interesting and characteristic have not yet been mentioned—those that depend upon similarities of imagination and general mental development. Both savage and child are ignorant of the laws of Nature, and the part that is taken by science and knowledge among the civilized and adult is in them filled by a vivid imagination, substituting faint and fanciful analogies for logic, and flourishing upon a *naïve* credulity. Consider what a large part chance and luck, which have been aptly termed the measure of our ignorance, play in the lives of savages and children. To the savage an appeal to chance takes place upon every occasion, and the issue is regarded as the expression of a powerful force; the same grade of concepts have a most tenacious hold upon children. What boy has not carried an odd stone, or an old penny, or a pet marble, for "luck"? To what boy would not the reasoning of the Indian, who prefers "a hook that has caught a big fish to a handful that have never been tried," not seem natural and valid; although he might not go so far as the Bushmen, "who despise an arrow that has once failed of its mark," and so rather make new ones than collect those that have missed? How many childish superstitions are based upon a tracing of cause and effect with no stronger evidence than that of the people whose chief died after breaking off the anchor of a stranded vessel, and who accordingly bowed to the anchor, trying to appease its revenge! When a boy tosses a second penny after one that is lost in order to find it, perhaps repeating a formula in so doing, or when he takes care not to step on the cracks between paving-stones in going to school for fear of failing in his lessons, he is actuated by a train of thought easily paralleled among almost any primitive people. When the Malays eat tiger, "to acquire the sagacity as well as the cunning of that animal," or the Dyaks refuse to eat deer for fear of becoming faint-hearted, or the Caribs eschew pigs and tortoises for fear of having their eyes grow small, "the idea may seem absurd to us,"

says Sir John Lubbock, "but not so to children. I have myself heard a little girl say to her brother, 'If you eat so much goose you will be quite silly,' and there are perhaps few children to whom the induction would not seem perfectly legitimate."

Consider furthermore the world of fable and fairies, in which children live and move, in which no laws are adhered to or transgressed, in which nothing is impossible and nothing expected, and we are in quite the same atmosphere as that in which savage myth and belief flourish and multiply. Many such myths are doubtless earnest attempts at explaining natural phenomena, and we can not but be struck with the fact that the childish attention is spontaneously directed to the same kind of problems, and often gives them very similar answers. The same mental tendency invests inanimate objects with mysterious powers and creates the belief in fetiches, in some occult connection between a force, power, or demon, and something that is regarded as its representative. The savage mind requires some concrete object upon which to hang the epithets and work the spells; no matter by what far-fetched analogy the two are regarded as connected, the fetich serves as a substitute of a more abstract notion, too vague for the savage's weak mind to retain. The name, the image, the shadow, the picture, a part of the person or dress thus acquire a peculiar relation to the person or object in question, and we meet with names that are tabooed, sorcery with a man's shadow or lock of hair, the dread of having one's picture taken, and the like. Analogies to these procedures among children could doubtless be traced had we a pertinent collection of their spontaneous sayings and doings. In the absence of such I must refer to the childish habit of talking to animals and obtaining answers from them, to their unquestioning faith in the personifications of fable, to the fact that of forty-eight children questioned by Dr. Stanley Hall "twenty believed sun, moon, and stars to live, fifteen thought a doll and sixteen thought flowers would suffer pain if burned"; or again, to the early and marked development of the dramatic instinct, that transforms everything and everybody into something else, and invests prosaic objects with an endless variety of qualities and histories. This is the function of toys; they form the lay figures upon which the child's imagination can weave and drape its fancies; and the doll, whether as some believe a direct descendant of the old-time fetich or not, is certainly related to it psychologically. The real and the ideal, the world of fact and the world of fiction, are divided in the mind of savage and of child by no definite boundaries, and are constantly confused.

We may linger a moment longer in our comparison of the childhood of the race and of the individual, to notice the possi-

bility of tracing similarities between the spontaneous attempts of children to imitate the social conditions under which their elders live, and the actual history of social and political institutions. Two striking illustrations of this have been recorded. Dr. Stanley Hall has described the evolution of a sand-pile into a farming community, under the promptings of the organizing play instinct of some New England boys. Farms, roads, houses, barns, men, women, cattle, tools, and so on, were fashioned, and in their growth we find mimicked the evolution of human industry, the problems of social life, the distribution of wealth, the invention of money, the fluctuation of prices, the tendencies that make the monopolist and the socialist. And yet it is distinctly play; the wooden farmers of the community being not unlike dolls, though possessing a personality with curiously real relations to the boys themselves. A more valuable illustration, because less of play and more of reality, is shown by the governmental and social regulations of the boys of the McDonough School near Baltimore, the description of which we owe to Mr. John Johnson. These boys roamed over eight hundred acres of land full of objects arousing a boy's desires and curiosity, such as birds' eggs and nests, rabbits, and nuts of all kinds. From an original common ownership in the land a few boys, by extra exertion and improvements, gained privileges over certain portions of it; and step by step as the number of boys increased, and the desirability of various bits of land was more clearly recognized, unwritten laws grew up, judicial procedure was inaugurated, testamentary power granted; money, which took the form of "butter" and school credits, introduced; and the intricacies of speculation, fluctuation of values, attempts at the redistribution of the soil, conservatism and liberalism gradually appeared as problems, and were solved in some satisfactory way. These and other phases of social and political movements had as intense a reality as in actual life, and in them Mr. Johnson finds many and striking analogies to the history of social and political institutions.

One further aspect of our train of thought deserves a moment's consideration, and this is the analogy between primitive mental traits and those appearing in the decay of mind, in arrested mental development, in hypnotism, and in other somewhat unusual and morbid psychic conditions. In the waning of mental powers we observe a remarkable law, by which the latest, least firm acquisitions are first lost, and the older, more deeply impressed, more primitive manifestations are longest retained. We thus possess an additional method of corroborating the various deductions above drawn, and in a sense truer than at first appears we have a "second childhood" the inverse of the first. To give a single instance where a detailed study would alone do justice, many of the

stages in the growth of language can be again studied in inverse order in diseases of language. In such disease the syntactical language is lost first, the more primitive gesture language is retained to the last; and Prof. Preyer has shown in full detail the striking similarity between the various defects and impairments of language, and the stages of its acquisition in children. In the arrested development of idiots we may observe a slow and gradual growth of faculties which in their normal rapid growth are so perplexingly interwoven as to make accurate analysis an exceedingly difficult task. Again, we have continued in idiots traits appearing in certain stages of child growth, but later outgrown; as, for example, a tenacious but mechanical memory, a delight in striking sense-impressions, an accurate mimicking of surrounding noises, a love of teasing and torturing animals, and the like. Finally, in hypnotism, in which condition we have a withdrawal of control by higher centers, a reduction to a more primitive grade of mentality, we see analogies to childish traits; the vivid imagination, the complete absorption of the mind of the subject in the one suggested act or object, his ready suggestibility, his keen perception and accurate mimicry, may perhaps indicate the line of thought here pertinent. Any and all such analogies may be easily carried too far, but essential and significant points of community may be traced without falling into this error.

I have thus attempted to lead the way through some of the fields in which modern psychologists have reaped a valuable harvest, and from which they expect a still richer fruitage as the result of a more thorough cultivation. To such of my readers as may feel that they have been hurried over the ground and allowed glimpses when protracted study would alone suffice, I can only offer the excuse of the professional guide, that there was much to show in a limited time. Those who may feel that they have been asked to consider things quite trivial and familiar, must take comfort in Mr. Bagehot's words that "small things are the miniatures of greater," and that my purpose has been accomplished if I have succeeded in freshening "their minds by object-lessons from what they know."

DEPARTMENT M—of Ethnology, Archæology, History, Cartography, etc.—of the Columbian Exhibition has been given one hundred and sixty thousand square feet of space in the gallery of the northern half of the Manufactures and Liberal Arts Building, together with a strip of land a thousand feet long and from one hundred to two hundred feet wide, along the border of the lagoon in the southeastern part of the grounds. Here the groups of native American peoples will be arranged geographically, and will be living under normal conditions in their native habitations during the six months of the Exposition. The scheme of classification of the department, as given in detail by the National Commission, covers a great diversity of subjects.

THE SYNTHESIS OF LIVING BEINGS.

By M. ARMAND SABATIER.

IF it is true that crude or dead matter and living matter are not separated by any impassable gulf, it seems reasonable to think that the resources of our laboratories, of which the power is increasing every day, will be able at some time to prove themselves capable of producing living matter from mineral. I purpose to discuss the legitimacy of this hope, taking into the account the results that have been already obtained, and appreciating the value of the objections that are opposed to it. It has long been supposed that the very complex substances that are the basis of living beings (plants and animals) could not be reproduced in laboratories by the simple combination of the forces which the chemist employs, and which reside in dead matter. "Vital force only," Gerhardt has said, "operates by synthesis and reconstructs the edifice that has been beaten down by chemical forces"; and Pasteur says, "We have not yet realized the production of a dissymmetrical body by the aid of compounds that are not so." These words of two illustrious chemists have met in modern labors a denial which is becoming every day more emphatic. Chemistry has entered upon the road of the synthesis of organic compounds, and has recently made a remarkable step, and has gone beyond a point which had been considered impassable.

Wöhler made the first synthesis in 1828, and obtained urea through the reaction of ammonia on cyanic acid. By taking simple bodies as the point of departure, we have been able to reproduce the carburets of hydrogen and formic acid; from the carburets we have gone up to the alcohols and to all their derivatives.* Berthelot produced alcohol by bringing together the gaseous body ethylene and sulphuric acid. The product of this reaction, decomposed by water, furnished alcohol. Wurtz obtained the synthesis of alcohol in another way. He subjected aldehyde to the action of nascent hydrogen, and alcohol was produced by the direct fixation of the hydrogen. As my colleague, M. Oeschner de Coninck, has remarked to me, this synthesis is of particular interest from the biological point of view, with which I am especially occupied; for everything tends to prove that this is the way alcohol is produced in plants. We are then in the presence of a case where the forces of the laboratory follow, for a given end, the same course as the forces of living Nature.

A considerable number of alkaloids of vegetable origin have been obtained directly by synthesis. M. Oeschner de Coninck, ap-

* P. Schutzenberger, Chimie appliquée à la physiologie animale, etc. Paris, 1864.

plying a special process of hydrogenization to the alkaloids of the peridic series, has pointed out a process of synthesis of the volatile vegetable alkaloids. He has obtained an alkaloid presenting the same composition as cicutine, differing from it only in a few physical and chemical properties, but possessing the same toxic action as the alkaloid of the hemlock.

These results, and others, were of a nature to cause hopes to rise; but still the synthesis of the sugars, and of the proteic substances which are the essential basis of protoplasm, seemed to defy the efforts of chemists.

To give an idea of the manner in which these results were regarded only yesterday by the partisans of the special, irreducible character of life, I quote a few lines from a book recently published (1886) by M. Denys Cochin, under the title Evolution et la Vie. After having recognized that modern chemistry entered with Wöhler and Berthelot into the way of synthesis; that it had made the synthesis of urea, formic acid, and ethylic alcohol; that these results had been for a long time regarded as contradictions of the laws of mineral matter and as impossibilities; and that, consequently, science has imitated some of the works of Nature, M. Denys Cochin adds (page 208): "These are arguments of which it would be wrong to exaggerate the weight. It is enough, to show this, to recall roughly the facts on which the discussion bears. Organic matter, vegetable or animal, is formed of very complex substances. The most complex, those which we may regard as the superior products of the synthesis performed by life, are the sugars and the albumens. These superior products are subjected during life to a slow combustion, which is fed by every effort and every expenditure of energy. The complex albumens are split and transformed into simpler albumens; the simplest of all is urea, a product of secretion, the waste of vital combustion; and urea itself splits into water and carbonate of ammonia. Organic matter thus returns to the mineral world. The sugars undergo a series of similar combustions and end by giving carbonic acid and water. . . . Now, the products of which chemistry performs the synthesis are always products of combustion, wastes of living matter, like alcohol, urea, and formic acid. They are never albumens of complex formula, not even sugars, the most perfect products of vital synthesis.

"Is there a line between superior and inferior organic products? Is there a characteristic that permits us to separate between them? Superior organic products are endowed with a curious power. Dissolved in water and traversed by a ray of polarized light, they cause the plane of polarization to turn at a certain angle to the right or the left. There is an unforeseen relation between this power of dissolved bodies and their crystalline

form. There exist right crystals and left crystals similar to one another as the right hand is to the left, but which can not be laid over one another; the direction of the deviation of polarized light corresponds with the direction of the crystalline form. It must be supposed that, after the solution of a right or left body, its separated molecules are still dissymmetrical. Of like character are the separate steps of a winding stairway; their form tells whether the stairs turned to the right or the left. Now, all superior organic bodies—the albumens, the sugars, dextrin, and cellulose—are what we call active bodies, endowed with the power of turning the plane of polarized light to the right or the left; and never by any artifice of the laboratory has it been possible to prepare directly a right body or a left body. In spite of the synthesis of alcohol, urea, and formic acid, we still have a right to say organic matter is not fabricated outside of the living being. The work of life can not be counterfeited. We can not artificially provoke the formation of a cell; we can no more reproduce the materials of which it is made. The substances we have been able to reproduce are only the waste of life returning toward inert matter, and already nearly mineral."

The analysis of these few pages can be summarized by saying that the synthesis of all the products of life, without exception, was long regarded as a contradiction to the laws of mineral matter and as an impossibility. Yet chemistry has performed the synthesis of some products of life—urea, formic acid, ethylic alcohol, etc. But the authors of the challenge do not acknowledge themselves beaten; they have simply drawn back and circumscribed the field of their defeat. "Yes," they say, "we acknowledge that chemistry has been able to perform the synthesis of some products of life; but they are inferior products, refuse. It has still been never able to prepare directly the superior products like albumen and the sugars. We can not counterfeit the work of life."

The reader has been able to view and measure the motion of retreat. We can, with a little kindliness, regard it as having been performed in good order. But we can also, with entire impartiality, see in it the first steps of a backward march which will end in a rout. We can indeed say that the rout has already begun. In fact, the reputed impassable has just been partly passed, and syntheses characterized as impossible have been in large part realized.

The synthesis of the most important of the series of sugars is now an accomplished fact. The researches which have permitted the realization of this immense advance in organic chemistry, and which are the work of M. Fischer and his pupils, have led to a discovery of great importance. In the series of sugars we met

an optical isomery identical with that of malic and tartaric acids. Sometimes the sugars present a right isomery, a left isomery, and an isomery inactive by compensation, and a splitting into two sugars, one right and the other left. This is exactly what we have witnessed in right and left tartaric acids, the union of which constitutes paratartaric acid, inactive by compensation. It is not useless to insist upon this resemblance, and to remark that the reactions which have permitted us to effect the synthesis of the principal sugars are of a purely chemical character, and that they demonstrate that the chemist can reproduce substances endowed with the rotatory power and aside from all intervention of life. The sugars, reproduced by synthesis, remain proteic or albuminoid substances. Here, again, the prophets of vital force are found wanting.

M. Grimeux in 1885 had prepared synthetically, by the action of oxychloride of phosphorus upon a mixture of leucine and tyrosine, and further treatment with NH_3 (ammonia), an amorphous, colloid substance, offering some of the characteristic reactions of albumen: precipitation on ebullition, the xanthoproteic reaction, the reaction of Millon, and the biuret reaction (soda and sulphate of copper). But M. Schutzenberger has just made a considerable step in the synthesis of those substances. A note in the *Comptes rendus* of the Institute of January 26, 1891, exposes the results of a successful experiment in the synthesis of a proteic substance presenting all the physical and chemical characteristics of the peptones.

An extended series of researches on the products resulting from the decomposition by hydration of proteic substances, albuminoid or other, under the influence of alkalies (baryta), have led M. Schutzenberger to attempt the synthesis of a proteic substance, starting from the simple terms of its decomposition by hydration. After numerous fruitless attempts he succeeded in forming a nitrogenous compound, which by its characteristics should be placed in the class of proteic substances, by combining, with the elimination of water, the ultimate and crystallizable products arising from the decomposition of albumen and fibrin under the influence of baryta. After a series of operations, of which I do not recite the detail, Schutzenberger obtained an amorphous product, soluble in water, precipitable by alcohol into white, cheesy lumps. The body thus obtained exhibited great characteristic similarities with the peptones. Its physical characteristics, its chemical reactions, and its modifications under the influence of heat, were faithfully like those of proteic substances. A great advance has therefore been made toward synthesis of organic substances, and the future promises still more complete results.

The chemist has then been able to realize the construction of

most of the complex compounds which appear exclusively reserved for the living organism. These compounds are not merely products of splitting or oxidation, wastes of life, but are also compounds like those which constitute the superior products of life. We should recognize that these products, that this albumen obtained by synthesis, while having the same elementary composition as living albumen and the same physical and chemical characteristics, is nevertheless distinguished from it by a very important point: it does not exhibit the characteristic phenomena of life. It is not capable of performing the part of a leaven, and has not the instability of living albumen. We have for the moment established only one thing: that the chemist is capable of creating, by direct synthesis, the most characteristic compounds and the highest products of life.

Will chemistry ever be able to produce living albumen capable of actively performing the part of a leaven, and endowed with sufficient instability to go through all the modifications that permit the combustions, splittings, and demolitions that lead to disassimilation and excretion? It seems to me that we are permitted to hope for it. But within what limits will this power of the chemist be included? Will he ever be able to make a living being? Will he succeed in making even a simple cell, a grain of starch, a muscular fiber, or any shapely and differentiated element? In order to answer these questions, we must dissipate some confusion and present all the elements of the problem.

To ask the chemist to make directly a differentiated being, or even a muscular fiber, a nervous cell, a grain of starch, is to ask him to do what Nature herself has probably never been able to do, and what it is probably impossible to realize. Can one in good faith exact so much? Is it not enough to ask the chemist to be as powerful as Nature? The question is then reduced to—Will the chemist be able to do what Nature has done? Let us see what Nature has done, looking from the evolutionist's point of view.

If the living form of matter was ever born by virtue of the action of natural forces, the event must have taken place in a medium the conditions of which differed from the existing conditions of our globe; for such formation of natural matter does not seem to be realized among us. Under these special conditions of the medium, living matter must have appeared in the most simple, the most rudimentary condition, for beginnings are always humble and little differentiated. We can conceive nothing of this kind more simple than droplets, more or less minute, of a substance comparable with albumen or protoplasm—that is, a substance fermentable and unstable in sufficient degrees for a current of vital exchanges to be established within it. The droplets

lived, increased in volume, and multiplied by division, because the vital exchanges could not be efficacious and properly regulated except on condition that the mass bore a well-determined proportion to the surface. If the mass became too great, the surface would become insufficient, the mass increasing in proportion to the cube of the radius, and the surface in proportion only to the square of the same radius.

The little protoplasmic masses created under special conditions of the medium would continue in that medium as long as it remained the same. But this medium becomes modified, because it ceases to be what it was—a fact clearly established by geology and paleontology—and we may presume that the modifications were made slowly and progressively. The little protoplasmic masses would also modify themselves and adapt themselves to the conditions created around them. The medium being changed, the living being would be changed too; but, the medium changed, the conditions that had permitted the direct formation of living matter, spontaneous or heterogeneous variation, would also have vanished. The new medium would then be such that the little living masses already created would continue to live, adapting themselves to it, but that new living masses could not be directly formed in it.

The first little masses born on the whole surface of the globe, unless the conditions were much more uniform than they are now, became the starting-point of successive generations, which, obeying the law of progress that presides over evolution and subjected to the conditions of the medium, acquired successively differentiations, very slow, but progressive, which determined in the homogeneous mass the appearance of granulations, localizations, limited condensations, partitionings, networks, etc., that made of the homogeneous droplet a more or less complicated organism. Such were the very slow advances, not becoming perceptible till after very long periods and through millions of successive generations. The nucleus of the cell, the muscular fiber, the nervous cell, the grain of starch, the fatty globule, the secretory cell, etc., were not formed by Nature at the first stroke. They are probably the result of work performed during millions of years and through milliards of generations. These milliards of generations of living droplets or living cells have therefore been as many little laboratories, in each of which has been elaborated, perfected, and differentiated the muscular fiber or grain of starch. Each of these little laboratories has brought to this work some share of activity, and each has added something to the differentiation.

Some, for example, have begun by producing more specially contractile particles in the homogeneous protoplasm; others have

accumulated these particles in particular regions. This concentration is effected very slowly, very progressively. In other ulterior droplets, these regions have progressively delimited themselves; later on, the motions of contraction have gradually oriented themselves to one direction rather than another; still later, this habitual direction of alternate contractions and elongations has determined the formation of the contractile substance into fibrillæ arranged in the same direction, and has achieved the formation of muscular fibers; and so on.

Nature, therefore, has not accomplished the formation of differentiated elements at the first stroke. It has created living matter, simple and homogeneous; and this has been called, through a considerable series of ages and generations, to elaborate the differentiated elements with which we are acquainted. More than Nature can do must not be demanded of the chemist. Those who ask him to create directly the cell and muscular fiber infinitely exceed the absurdity of the persons who would tell the miner, whose business is limited to extracting the mineral, to make an iron-clad vessel with his ordinary tools and methods. He could supply the mineral, but a metallurgist would be needed, with furnaces, retorts, and reagents, to extract the crude metal from it. After him would have to come, to conceive and draw the plans, the founder, men to manipulate the rollers and the hammers, the turners, the polishers, the fitters, and the builders proper, all of whom would contribute in succession and through a long series of days to the preparation, the perfection, and the starting of the various parts of the great vessel; and all this under the eye and direction of the engineer who has conceived the plan and ordered the execution of the work, and provided the means of carrying it into effect.

In like manner an innumerable series of minute workers and minute laboratories have contributed, in conformity with the plan of the Creator, to the differentiation of muscular fiber, of the starch-grain, and of the nervous cell.

What can be expected of the chemist is thus well defined and outlined: it is to create simple living matter—albumen or protoplasm—as Nature has created it. We are authorized to believe that he can do this by the progress that has been recently and rapidly made in organic syntheses.

We have remarked, it is true, that, although the synthesis of albumen has been effected, living albumen, active like that of protoplasm, endowed with a strong leavening power and an instability adapted to vital changes, has not been produced. It is not impossible, as Pfluger believes, that non-living and active albumen are isomers—that is, bodies having the same elementary composition, and differing only in the arrangement of the atoms in the molecule.

Chemistry has already given proof that it is competent to produce isomeric changes in a considerable number of bodies (as we have seen for hyposulphite of soda); and nothing permits us to certify that, after having produced non-living albumen, it will not ultimately find means to determine in it the isomeric change which will make living albumen of it. It is proper to remark, besides, that life itself produces two isomeric states of albumen: one, the active state in protoplasm; and the other, the passive or inert state in the albumen of the egg, in birds. The latter, which is destined to feed the embryo, may be preserved intact for years, and show itself indifferent to oxygen, which can neither oxidize it nor contribute to its breaking up. It should be remarked, besides, that this albumen, deprived of the leavening power, is a product of secretion of the cells of the oviduct—a fact which comes to the support of the thoughts I have expressed above on the mechanism of excretion.

To create simple living matter the chemist may follow different ways. He may exactly reproduce the conditions of the medium which have favored the appearance of living matter; or, he may find new conditions that will lead to the same result, by producing, for example, the isomeric change of which we have just spoken. The same synthesis may, in fact, be produced in different ways, as has been seen in the case of alcohol. Will the chemist ever realize either of these conditions? Who can say peremptorily, No? The creation of living matter by chemistry is not, therefore, *a priori* absolutely impossible.

But, supposing these conditions realized, will the chemist be able to give rise to parcels of living matter which, like the first created at the origin of life on the globe, can become the starting-point for successive generations and for a new evolution in the present conditions of Nature? It seems to me that the answer to this question must be negative—for the reason that the first created parcels lived and were propagated through a long series of ages, among the same conditions as prevailed at their birth; they have since subsisted, notwithstanding the modifications of the medium, because those modifications, slow and taking long spaces of time, have permitted living matter to modify itself slowly and adapt itself to the new conditions. The question, then, amounts to asking, Will the chemist who shall realize, during a sufficient time and within a limited space, the conditions that formerly presided over the formation of living matter, be able to maintain them during sufficient time or to modify them slowly enough for living matter to have to adapt itself and enter into useful and conservative relations with actual Nature? If we consider the time Nature has required to reach this result of adaptation, we may logically conclude that such experiences are utterly outside of the

conditions permitted to human experience. If, then, man shall some day create living matter, he will be able to observe it during a longer or shorter time; he will be able to study it; but it will be an embryo, the development of which can not be completed, on account of the absence of suitable conditions of the medium.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

ECONOMICAL TREES.

By FREDERICK LE ROY SARGENT.

THE well-known power which many plants possess of developing adventitious roots from almost any part, when placed under favoring conditions, is manifested in a somewhat extraordinary manner by several trees recently brought to the notice of botanists.

In the Bulletin of the Torrey Botanical Club for August, 1891, the present writer published an account of a linden growing in Boston, Mass., where it had been subjected to injury from horses gnawing the bark, and in consequence had a considerable portion of the trunk decayed, as shown in the accompanying sketch (Fig. 1). At the edge of the wound the cambium had formed a callus, and from a point in this living tissue there proceeded several vigorous roots which penetrated the decaying wood in all directions, evidently finding a rich soil.

Subsequent issues of the Bulletin have contained descriptions of several other examples of trees exhibiting a similarly economical utilization of the products of their own decay. These include swamp maples, a Norway maple, a willow, and a white mulberry. In an English paper appeared not long ago an account of an oak which had "sustained itself for years by a mass of roots grown into its own trunk!"

In one of the swamp maples observed by L. M. Stabler, at Great Neck, Long Island, the primary injury apparently resulted from a storm which split and twisted the trunk. One of the adventitious roots, "at least two inches in diameter, started as high as ten feet above the base of the trunk, and passed down through the decayed portion to the ground" (Fig. 2).

The Norway maple, described by W. A. Buckhout, had "a large branch split off, showing that the splitting had started several years before, that the margins of the trunk had become well calloused, and from several points roots had extended into the cleft, which naturally became partially filled with dust and decaying bark. The largest root was an inch in diameter, divided considerably near the lower end, and was over two feet long."

Of the small white mulberry growing on the grounds of the Department of Agriculture at Washington, Mr. Sudworth says: "The conditions are essentially the same as those noted in the case of the linden, except that the mulberry is perhaps more seriously injured, a considerable portion of the trunk having been destroyed by decay. The adventitious roots observed spring from the free border of a longitudinal crack where the trunk forks, the edges of the wound having been healed for some time, while the subsequent decomposition of the inner layers of wood formed a quantity of mold, which, lying in contact with the

FIG. 1.—PORTION OF TRUNK OF LINDEN, GROWING IN BOSTON, MASS. (Sketched by the writer.) From the Bulletin of the Torrey Botanical Club.

FIG. 2.—PORTION OF TRUNK OF NORWAY MAPLE, GROWING NEAR STATE COLLEGE, PENNSYLVANIA. (Sketched by William A. Buckhout.) From the Bulletin of the Torrey Botanical Club.

healed borders, seems to have induced the growth of adventitious roots from one side into the decayed mass." *

To this list may now be added another mulberry (Fig. 3) observed by the writer during the past winter in Thomasville, Ga. Its owner, Dr. T. S. Hopkins, says of it: "I have had an intimate acquaintance with this grand old tree for thirty years. I do not know how old it was when I first knew it. Some fifteen years ago it was uprooted by a storm. I carefully amputated its limbs and re-erected its body. It lived and improved, and to-day furnishes as much shade as it did before its fall and the surgical operation made necessary by it." In point of size, extent of decay,

* In a letter dated July 26, 1892, Prof. B. E. Fernow, Chief of the Forestry Division at Washington, informs me that while in Harrisburg, Pennsylvania, he saw a most interesting and well-developed example of self-rooting capacity in a paper mulberry (*Broussonettia papyrifera*). The tree stands opposite to No. 31 South Front Street in that city.

and the number and thickness of its adventitious roots it would seem to be much the most striking example of an economical tree thus far described. The trunk is now about three feet or more in diameter, and so much decayed as to leave merely a shell of

FIG. 3.—TRUNK OF MULBERRY, GROWING IN THOMASVILLE, GA. (Sketched by the writer.)

no great thickness. The adventitious roots are some of them as thick as a man's arm. They all ramify through the disintegrating heart of the tree, and the longest of them appear to reach

the earth. Besides saving from waste the products of decay, these roots must add considerable strength to the weakened trunk. This feature is perhaps all the more significant in view of the mulberry's near kinship with the banyan tree, which makes such wonderful mechanical use of aërial roots.

With regard to the way in which such economizing roots originate, and their physiological significance, it seems clear, as Mr. Sudworth has suggested, that the conditions necessary for their production are essentially the same as those favoring root-production in cuttings and layered branches. That is to say, given a vigorous cambium or similar formative tissue, near a more or less injured region, the presence of moisture for a certain period, and a congenial soil, then adventitious roots may be expected to appear. That in all the cases above cited these conditions were most probably present antecedent to the appearance of the roots seems surely to be a fair inference from all we know regarding them.

When, as in Mr. Buckhout's maple, there is opportunity for dust, etc., to accumulate in a small cleft near the callus, before total separation of the limb, the conditions are practically the same as in those not uncommon cases where seeds are found to sprout in the fork of a tree and grow for a number of years.

Now that the attention of observers has been called to this curious power which trees have of making the best of a bad matter, it will doubtless be found that the phenomenon is of more common occurrence than was at first suspected.

THE LATEST ARITHMETICAL PRODIGY.

By M. ALFRED BINET.

MATHEMATICIANS, doctors, and philosophers have lately enjoyed a rare opportunity to study a new calculating prodigy, a young man twenty-four years old, who performs mentally, with surprising rapidity, operations in arithmetic involving a large number of figures. We purpose, pertinently to his case, to consider the psychological aptitudes which serve as the basis of mental calculation. We shall use in our study the report of the committee of the Academy of Sciences which examined M. Inaudi, and the results of our own personal observations of his powers, by which we are convinced that he can bear comparison, for the extraordinary development of his memory, with all other known calculators. Jacques Inaudi was born at Onorato, in Piedmont, on October 13, 1867, of a family in modest circumstances. He passed his earlier years in tending sheep. At the

age of six years he was taken with a passion for figures, and began to combine numbers in his head while at watch over his flock. He did not try to give his calculations a material form by counting on his fingers, or with stones, but the whole operation was mental. He conceived numbers by the names which his elder brother had recited to him. Neither he nor his brother could read then. He learned by ear the numbers to hundreds, and exercised himself in calculating with what he knew. When he had done his best with these numbers he asked to be taught those above a hundred so that he might extend the sphere of his operations. He has no recollection of his brother teaching him the multiplication table. At seven years of age he was capable of performing in his head multiplications of five figures. In a little while he started with his brother to wander through Provence, the brother playing the organ and Jacques exhibiting a marmoset and holding out his hand. To increase his receipts he proposed to the people he met to perform mental calculations for them; at the markets he assisted the peasants in making up their accounts, and performed difficult arithmetical operations in the *cafés*. A manager engaged him to give representations in the cities. He came to Paris for the first time in 1880, and was presented to the Anthropological Society by Broca, who wrote a brief note on the case.

Since 1880, M. Inaudi has made great progress. First, he learned to read and write, and then the sphere of his operations widened. His education, which was slow, is still rudimentary on many points; but he has a receptive intelligence and an inquiring spirit, is pleasant and modest, converses agreeably, with good sense, and sometimes with irony; and is ready at cards and billiards. It would be wrong to regard him as a simple calculating machine.

The operations he performs are additions, subtractions, multiplications, divisions, and extractions of roots. He also resolves by arithmetic problems corresponding with equations of the first degree. These are to him exercises of mental calculation, by which we mean a calculation made in the head, without the employment of figures or writing, or any material means to assist the memory. His general process is as follows: first, when the problem is stated to him aloud, he listens attentively and repeats the data, articulating them clearly, to fix them well in his mind; if he does not comprehend the problem, he has it repeated. It may be communicated to him by writing, but he prefers to receive it by hearing; and if we insist upon his reading it, he pronounces it in a low tone. When he has fully grasped the question, he says, "I begin," and proceeds to whisper very fast, in an indistinct murmur, in which we can catch from time to time a few names of numbers. At such times nothing can

move him or distract him; he performs the most complicated operations in the midst of the excitement of public representations. He can even talk while mentally working; he answers questions properly, and even keeps up a regular conversation without disturbance to his arithmetical operations. During his exercises he is sometimes seen to lift his hand to his forehead or to close his fist, or to draw imaginary lines with the forefinger of his right hand in the palm of his left hand. These are little tricks of no importance, that vary from one day to another. Finally, after an interval which is always short, he says, "I am done," gives the solution of the problem, and proves it for his own satisfaction.

The two remarkable features in M. Inaudi's mental calculations are the complexity of the problems he undertakes, and, in a less degree, the rapidity with which he finds the solution. Most of the questions that are put to him involve the use of a considerable number of figures; he can add in his head numbers composed of twelve ciphers each; he multiplies by one another numbers composed of eight or ten figures each; he tells how many seconds there are in an arbitrarily selected number of years, months, days, or hours. These operations, to be well carried on, require the subject to keep in mind the data of the problem and the partial solutions till the moment when the definitive solution is found. For so considerable a task M. Inaudi takes, they say, an extremely short time—so short as to convey the illusion of instantaneousness. It has been published on this subject that "he adds, in a few seconds, seven numbers of eight or ten figures. He completes the subtraction of two numbers of twenty-one figures in a very few minutes, and finds as rapidly the square root or the cube root of a number of from eight to twelve figures, if the number is a perfect square or cube, but needs a little more time if there is a remainder. He likewise finds, with incredible celerity, the sixth or seventh root of a number of several figures. He performs a division or a multiplication in less time than it takes to announce it." M. Inaudi found in thirteen seconds the answer to the question, How many seconds are there in eighteen years, seven months, twenty-one days, and three hours?

But while M. Inaudi calculates rapidly, he is not much more rapid than a professional calculator who is permitted to work out his problems on paper; M. Inaudi's merit is that he performs his operations in his memory.

His processes are not ours, and although he has been able to read and write for four years and is acquainted with the ordinary methods of calculation, he does not use them. M. Charcot caused him to perform at the Salpêtrière two divisions of equal difficulty, one on paper according to our method, and the other in his own way; the second required four times less time than the first.

M. Inaudi, faithful to the processes of his infancy, manages them with surprising dexterity. He has perfected, developed, and enlarged them, but has not changed their nature.

The basis of his calculations is multiplication; even in dividing or extracting the square root, he multiplies. He makes a series of multiplications of approach. In a division, for example, he finds the quotients by groping; seeking and trying a number which, multiplied by the divisor, will produce the dividend.

He follows a course in multiplication which is peculiar to him. If more than one figure is included, he does not perform the process all at once, for he has no more extended multiplication table than ours; but his method consists in decomposing a complex multiplication into a series of simpler ones. If he is to multiply 325 × 638, M. Inaudi calculates thus:

300 × 600 = 180,000	300 × 8 = 2,400
25 × 600 = 15,000	25 × 30 = 750
300 × 30 = 9,000	25 × 8 = 200

In short, he makes six multiplications instead of one. He begins on the left, multiplying, therefore, the figures of the highest value. In other cases he changes the data around. Instead of multiplying by 587, he multiplies by 600 and then by 13, and subtracts the second product from the first. The observation of M. Inaudi brings a new factor to the theory of partial memories. It is usual to employ the word memory in a general sense to express the property, common to all thinking beings, of preserving and reproducing the impressions they have received; but psychological analysis and a large number of facts in mental pathology have shown that memory should not be regarded as a sole faculty, having a distinct seat; in the final analysis, memory is a group of operations. There exist, according to the report of the committee of the Academy, partial, special, local memories, each of which has its special domain, and which are so independent that one of them may be enfeebled, may disappear, or may develop to excess without the others necessarily presenting any corresponding modification. The older psychologists missed this truth. Gall was probably the first to assign its proper memory to each faculty, and founded the theory of partial memories. It is at the present time supported by multiplied facts, a large number of which have been furnished by M. Taine. He has cited, among others, the cases of those painters, designers, and statuaries who, after having carefully regarded a model, can make its portrait from memory. They supply fine examples of the development of visual memory. Then there are cases of musical memory. The subject has been revived of late years in the study of diseases of language. Cases have been cited of patients in whom the single memory of language, very limited and special, is abolished, while

the other memories remain intact; there are patients who, without being paralyzed, can no longer write, but continue to speak; others lose the faculty of reading while they keep that of writing, so that they can not read the letter they have just written.

The study of arithmetical prodigies presents the same question under another aspect: no memory is destroyed in them; but one of the memories, that of figures, acquires an abnormal extension that excites enthusiasm and admiration, while the other memories, regarded as a whole, present nothing peculiar. They even sometimes continue below the common grade. Subjects of this class are real specialists who interest themselves during the whole course of their existence in but one thing—numbers. Pertinently to this point, a characteristic anecdote is related of Buxton, a celebrated calculator, who was taken to a performance by Garrick. At the conclusion of the play he was asked what he thought of the piece. He replied that a certain actor had entered and made his exit so many times, and had pronounced so many words, and so on. That was all the recollection he had of the play. The committee of the Academy has taken the measure of the different kinds of memory in M. Inaudi, and has concluded that he has not a greatly developed memory for forms, events, places, or musical airs, and I have found that his memory for colors is very weak. He gives surprising results only in numbers. This inequality in the development of memories assumes a remarkable character when we compare in him two things nearly identical, the memory for figures and that for letters. A series of letters was pronounced in his presence which he was asked to repeat exactly, and the same was done for figures. It would seem at first sight that the articulated sound of a pronounced letter would be as easy to hold in the ear as that of a figure, so that a person capable of repeating, for example, twenty-four figures, as M. Inaudi does without much effort, would have no more difficulty in repeating twenty-four letters. But this was not the case. It was found, not without surprise, that M. Inaudi could not repeat more than seven or eight letters from memory. He hesitated, lost his usual self-possession, and wanted to withdraw from the experiment; and when two lines of French were read to him, he could not repeat them exactly after a single hearing.

The recollection of the figures is a necessity for every mental calculator. It is of service to him, first in retaining the details of the problem, and then in retaining the partial solutions till the complete solution is found. The complexity of the problems which a person can hold in his head gives an idea of his memory. But there is a more direct and simpler means to measure the extent of the memory for figures, and that is to cause him to repeat a series of figures, seeking to find by trial the maximum

number that he can repeat without mistake. Such trials are common in psychological laboratories. According to my personal observations, persons can repeat on an average from seven to ten figures without making a mistake, when they are pronounced with a rapidity of two per second. The division of figures into groups, the special vocal intonation, or some kind of rhythm, are artifices which may sometimes increase the number, and make the effort to repeat less painful. These results agree with those of an American psychologist, Mr. Jastrow, who mentions 8.5 as the average number found among pupils in his country.

M. Inaudi has practiced this kind of repetition for a long time. We repeat the number, dividing it into periods of three figures each, and giving the value of each period. For example, to make him repeat the number 395,820,152,873,642,586, we give it out, three hundred and ninety-five quadrillions, eight hundred and twenty trillions, one hundred and fifty-two billions, eight hundred and seventy-three millions, six hundred and forty-two thousand, five hundred and eighty-six. We are careful to dwell on the articulation of the numbers. M. Inaudi repeats, as fast as he comprehends it, each period of three figures; then, when he has taken in the complete number, he says confidently, "I know it," and repeats the whole series with great volubility.

I have witnessed his repetition in this way, without mistake, of a series of twenty-four figures. M. Charcot, in order to compare his capacity with that of Mondeux, another famous calculator, repeated with him the experiment, which had been tried with Mondeux, of telling off a number of twenty-four figures, divided into four periods, so that he might announce at will the six figures included in each of the periods. Mondeux took six minutes to reach the result; M. Inaudi only had to hear the figures given out. Thus a single hearing suffices M. Inaudi to fix in his mind a long series of figures or the statement of a complicated problem; he does not go back to repeat the numbers several times as we are obliged to do. He only asks, when the series of figures is a little long, to have it pronounced slowly. Once fixed in his memory, the number is retained with a precision and sureness which it is hard to conceive. M. Inaudi can not only repeat a number of twenty-four figures in the order in which he heard it, but in an inverse order, beginning with the units; he can repeat half the number in one direction, and the other half in the other direction; and all this without hesitation, without fatigue, and without mistakes.

Ordinary persons can recollect a number of many figures only a few seconds unless they have aids to their memory. M. Inaudi's memory retains for a very long time the numbers that have been given to him. He is in the habit of repeating at the

end of a sitting all the numbers on which he has been set to work, in the different questions put to him. This experiment, which I saw made at the Salpêtrière, gives really incredible results. A large number of problems were given to M. Inaudi during the afternoon, the data of all of which were preserved in writing, in order to verify the exactness of the repetition. On this day he repeated two hundred and forty-two problems. It is said that he repeated four hundred at a sitting given in the Sorbonne.

These numbers, however, should not be taken as the measure of M. Inaudi's memory for figures, because he did not learn them one after another, without interruption. They were contained in distinct experiments, in which the calculator burdened his memory each time with only twenty-four figures. He therefore had intervals of rest, however brief; and these rests probably facilitated the assimilation of the whole mass, which was really enormous. Usually, he told us, he did not try to retain groups of more than twenty-four figures. One day, twenty-seven were given out to him. That was the maximum number that was essayed. I proposed to him to recite twenty-six, and he was able to repeat them all exactly by employing his usual processes. The experiment tired him a little. After a short rest, I read fifty-two figures to him. In the middle of the experiment, when he had reached the twenty-sixth figure, I pronouncing them and he repeating them, he stopped. He was troubled, and expressed a fear that he would forget the whole. He then repeated rapidly from memory the figures which had just been pronounced, after which he asked me to continue. I went on then to fifty-two figures. He then tried to repeat them all. He did it, but with some transpositions and confusions, and about ten mistakes. The number fifty-two seems to constitute a limit for him.

We have now to examine a little more closely what is meant by the memory for figures; for there are an immense variety of psychological types, and the same mental operation may be comprehended and performed by two persons under absolutely different forms. There are many ways of fixing figures in the memory and calling them out again; or, in other words, several images of a different kind are employed. According to the investigations of the committee of the Academy, M. Inaudi's processes are the contrary of those which arithmetical prodigies are generally supposed to use.

These persons, according to their own testimony, are accustomed to take visual memory as the basis of their mental operations. They have an inner vision of the numbers that are pronounced, and those numbers, during the whole time of the operation, stand before their imaginations as if they were written on a tablet set before their eyes. This process of visualization

was that of Mondeux and Colburn, and of all who have given clear explanations of themselves. With this, nothing is easier than to account for the faculty of mental calculation—that is, of calculating without reading or writing anything. Whenever any one has a clear and sure visual memory, he does not need to have the figures before his eyes to read them and write them out in order to be able to combine them; he can turn away his eyes from the slate, because they are written as if with chalk on the tablet which his memory presents to him. This explanation appears so satisfactory that Bidder, one of the greatest mental calculators of the century, wrote in his autobiography that he could not comprehend the possibility of mental calculation without this faculty of representing the figures to himself as if he was looking at them.

This interpretation has been confirmed by the researches of Mr. Galton. Inquiring of a large number of calculators and mathematicians of every kind and every age, he has learned that most of them have a visual image of the figures during their calculations; the natural series of figures is presented in a straight line, or follows the bendings of a curved line. With some persons the figures appear placed as if in relation to the rounds of a ladder; with others they are inclosed in squares or circles. Mr. Galton calls these images number-forms. The visual image must be very clear for it to be possible to recognize so many details. M. Taine, who has studied the phenomenon of the image with much care, has discovered a resemblance between mental calculators and checker-players who do not have to look at their boards. He explains their faculty by the clearness of their visual images. "It is evident," he says, "that every move, the figure of the whole checker-board, with the order of the different pieces, is presented to them as in an inner mirror; else they would not be able to foresee the probable consequences of the move that has been made upon them and of the one they are about to order." The direct testimony of players confirms this interpretation. "With my eyes turned to the wall," says one of them, "I see at once the whole board and all the pieces as they really stand. . . . I see the pieces exactly as the turner has made them—that is, I see the checker-board in front of my adversary, and not some other checker-board."

In the light of so many facts we are naturally led to believe that all mental calculators work by the considerable development of their visual memory. But the study of M. Inaudi shows that we can not draw a general conclusion from them, and that there are other means than mental vision that seem to have the same efficaciousness and power. M. Inaudi declares that no figure is presented to him under a visual form. When he endeavors to retain a series of twenty-four figures that have just been pro-

nounced, or when he combines numbers to solve a problem, he does not see the figures, but hears them. "I hear the numbers," he says distinctly, "and it is my ear that retains them. I hear them sounding in my ear, just as I have pronounced them, in my own voice, and that inner hearing persists through a good part of the day." At another time he told M. Charcot: "Sight is no help to me; I do not see the figures. I will say even that I have more difficulty in recollecting the figures and the numbers when they are communicated to me in writing than when I receive them by speech. I feel cramped in the former case. I do not care about myself writing the figures. Writing does not help me recollect them. I prefer to hear them."

His words are confirmed by his actions. When the numbers are given to him written, he pronounces them aloud, putting himself in substantially the same position as if they had been communicated to him by the hearing; then, when he begins his calculation, he turns his eyes away from the written figures, the sight of which, instead of aiding his memory, is only an embarrassment to him. "How can I depend on seeing the figures," he says, "when it is only four years since I learned to read and write? Yet I calculated mentally before that time."

Our supposition that M. Inaudi relies on auditive images in his calculations is not absolutely correct. A pure auditive image is very rare. Auditive images and sensations of words are associated with the motions of the larynx and the mouth required to pronounce them; and when a person represents to himself a word under the form of a sound, he should at the same time experience special sensations in the organs of phonation, as if the word was about to be pronounced. In other words, so far as concerns language, the auditive type has the closest connections with the motor type; the two are often combined.

This probably takes place with M. Inaudi. We have seen that his lips are not wholly closed when he is at work. They move a little, and an indistinct murmur issues from them, in which we may catch from time to time a few names of figures. The whispering sometimes becomes so intense as to be heard several metres off. I have assured myself, by taking the respiratory curve of the subject, that it bears very clear marks of this phenomenon, even when we do not hear it. His sounding organs are then really active while he is calculating in his head. M. Charcot, wishing to determine the importance of these movements, and see what would happen if they were not executed, asked M. Inaudi to make a calculation with his mouth open. But this device did not wholly prevent the motions of articulation, which were still apparent. I tried to prevent M. Inaudi from articulating sounds in a low tone, and asked him to sing a vowel during his calculation;

if the sound of the vowel kept pure in tone, it was certain he did not articulate the figures. The experiment caused M. Inaudi great embarrassment. He was still able to calculate in his head, but it took him four or five times as long as under the usual conditions, and he succeeded in doing it only by cheating a little—that is, he made some articulations of figures in a low voice, the production of which was at once detected on listening attentively to the sound of the sung vowel.

These experiments showed that articulation constitutes an integral part of M. Inaudi's mental calculations, as well as that every experimental artifice that interferes with articulation makes the calculation longer or modifies its accuracy. In other words, M. Inaudi uses auditive and motor images of articulation concurrently. We have no experimental means of determining which is the predominant factor. M. Inaudi thinks that the sound guides him, and that the motion of articulation intervenes only to re-enforce the auditive image. We might be liable to suppose, in view of the part that is played by the memory in mental calculation, that it is the only faculty developed in arithmetical prodigies; and some authors have fallen into this error. But it will be well to guard against such a supposition, which is contrary to the most certain and best established psychological facts. If we take any elementary act of the mind and analyze it, we shall find that it involves the concurrence of a large number of co-ordinated operations; with much stronger reason must such a concurrence be supposed necessary for acts as complex as mental calculations. We have found in our studies of M. Inaudi that a considerable number of his faculties have attained an extreme development, and they are precisely the ones that concur in operations of mental calculations. Perception, attention, and judgment, to the extent and in the shape in which they are needed in his work, have acquired the same perfection as his memory for figures.

It remains to inquire how these aptitudes for calculation have been formed. When we examine the history of these arithmetical prodigies, we are struck by the three facts of their precocity; the impulsive, in a certain sense all-possessing, character of their passion for calculation; and the generally illiterate, often miserable, medium in which they have grown up. Their stories have many traits in common. They are most frequently children of poor and ignorant parents. They are seized with the passion for calculating in their earliest years—at from five to ten years of age on the average—the age when most children are living in the illusions of plays and stories; they begin to combine numbers in their heads, apparently without any exterior provocation, and without the influence of parents or schoolmasters. As they grow up

some of them become mathematicians like Gauss and Ampère, while others continue all their lives what they were in the beginning, simply specialists in figures. We do not know whether this distinction arises in the nature of things, or simply results from the chances of life. Very good minds think there is a relation between the calculating faculty and mathematical talent, and believe that, if these prodigies were intelligently given a special education, they might most of them become remarkable mathematicians. Experiment has not given a definite result on this point. M. Inaudi has determined not to go to the mathematical school, but will preserve and develop his natural gifts. Another question arises as to the influence of heredity in these cases. For a long time physicians have been accustomed, when an abnormal combination of talents appears in a particular person, to find a number of special characteristics in his family. Sometimes these have appeared through several generations, as in certain noted families of musicians and naturalists. Sometimes the peculiarity appears in the shape of eccentricity. No such peculiar family traits have been found associated with M. Inaudi, nor any special antecedents in himself. He has never been ill, and his development has been normal.

The study of M. Inaudi has been fruitful for psychology. On one side it has brought a remarkable confirmation to the theory of partial memories; and on another side it has made us familiar with a new form of mental calculation, the auditive form. It may also have taught us something else. We have found that it is possible for some faculties, like memory, to acquire an extent double and triple that of the normal. The fact permits us to descry in how large a measure the human mind is still capable of improvement.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

THE polished stone hatchet, according to Mr. Thomas Wilson's report on anthropology at the Paris Exhibition in 1889, is recognized almost all over Europe as an amulet protective against lightning. It is called in many languages "the stone of lightning" or "thunder-stone." The hatchets are drilled for suspension, or are put over the fireplace or in the stones of it, or are inserted in a crack. The general belief is that they come from the heavens in a flash of lightning; and one peasant declared that he had seen such a stone fall, and, going for it, had found it and extracted it from the hole still hot. Flint arrow-heads are also regarded in the same way. A common amulet, of great power, in Brittany is what is called there the *pierre du croix*, a mineral, staurolite, which crystallizes in the form of a cross. It is regarded as a token from God in favor of the religion of the country, and is given to these his chosen people in recognition of their piety and religious fervor. In Italy the coral is an amulet supposed to guard its owner against the evil eye. These are the principal objects of regard; but there are many others of less importance, which are, however, much relied upon.

REASONING ANIMALS.

By ALLEN PRINGLE.

THE question as to whether animals reason or not is a disputed one. For myself I am convinced that they do, and with more logic sometimes than some of the *genus homo*. The notion that what we observe as mind in animals is all instinct and no reason ought to have taken its departure with the discovery that the animal had a brain and nervous system quite similar to that of man, and subject to the same general mental and physiological laws. The truth is, man has both reason and instinct, and so has the animal. Instinct acts spontaneously without thought, while reason reflects and adapts means to ends. When we wink with lightning rapidity to protect the eye from something flying into it, or when we start back in fright from a sudden and threatened danger, we act instinctively; the animal does the same. On the other hand, when we act from reflection and adapt means to ends, we exercise reason; the animal does the same thing. In our daily contact with our domesticated animals we find ample proof of this. I mention the horse, the cow, the dog, and the honey-bee, not because they are the only animals that reason, but because most people are specially interested in these domestic animals, and are familiar with their characters and habits. Many other animals exhibit a high degree of intelligence.

A most remarkable case of bovine intelligence which recently came to my knowledge, and for the truth of which I can vouch, has prompted the writing of this paper. A cow and steer—the latter two to three years old—were the only occupants of the barnyard where the occurrence took place. A baiting of hay was put out to them, the cow taking possession. The steer wished to share it; but the cow, like some higher animals, was selfish and was bent on taking the whole of it, and as often as he would manœuvre around from side to side to get a bite she would drive him off at the point of her horn. The steer was so persistent that at last the old cow's patience gave way, and making a determined and vicious charge on him, punished him severely, though he was her own offspring. The steer felt badly hurt, not only in body but evidently in mind as well, and immediately started out of the yard and off down the lane toward the pasture where were the rest of the stock, bellowing vengeance at every step in a language which was unmistakable to the bystander and which the mother well understood, as she ceased eating and listened intently to the threatenings of what was to come. When these died away in the distance she resumed her ration, but with evident apprehension. In due time the steer was seen returning, bringing with him a companion

larger and stronger than himself. As they approached, the rumblings of rage and revenge could be again heard, which grew louder as they came nearer. The cow took in the situation at once and was now terror-stricken. As her assailants rushed into the yard, she dodged them and rushed out at life-and-death speed, and away toward the rest of the stock in the field, with her pursuers close in her track.

Now, I submit that this is one of the cases which furnish incontrovertible proof that animals do reason. No amount of mere instinct could avail that steer in conceiving and carrying out the complex "plan of campaign" which he adopted to take revenge on the selfish and cruel old mother who refused to share her ration with him and punished him besides. The plan he so readily adopted required not only feeling to prompt it, but thought and reason to carry it out. The end to be attained was the punishment of his assailant, which he was not able to inflict himself, and he adopted the means necessary to accomplish the end. This was thought and reason, and not only so, but there was language as well, for what else were the threatening sounds he uttered and which the mother well understood; and how else could he have communicated his grievance and desires to his companion in the field? It will also be noted here that the steer exhibited in this case not only a measure of what is called man's highest faculty—reason—but a good deal of another passion which often rankles in the human breast—viz., *revenge*. It would be no loss to *us* to allow the "lower animal" to monopolize this "animal propensity."

The horse, as we all know, is even more of a reasoning animal than the cow. I knew of a horse who would leave his pasture under cover of darkness, and go some distance off over several fences into a field of grain, where he would help himself, and invariably return before daylight to his own pasture without disturbing a single rail on any of the fences he jumped. Others have had a similar experience. Here is not only reason, but a high degree of shrewd cunning worthy of a James or a Scotland Yard detective! I once had a wise, motherly old brood-mare who had lost an eye. In the case of her first foal after that loss I noticed that she would at first hurt the young colt when it happened to be on her blind side and she would make a move in that direction, sometimes knocking it down and hurting it with her feet. But very soon I perceived that when the colt was out of her sight on her blind side she would not stir till she first looked around for it to ascertain if it was in danger, and when she would not be able to get her head round far enough to see it, she would move slowly and with the utmost caution till she could see it. Here were manifested not only intelligence, but what the phrenologists call cautiousness, locality, and philoprogenitiveness.

We now come to the dog, which perhaps exhibits as high a degree of intelligence as any of the other "lower animals," and a higher order sometimes than the human. As an instance of this we may take the historical case (which seems to be well authenticated) of the human imbecile (not insane) and the Newfoundland dog and child on the bank of the river. As often as the imbecile would put the child in the water the dog would bring it out to save it from drowning; and when at last the child's life was in danger through exhaustion, the dog forcibly restrained the idiot from again putting it into the water. Here was a degree of reason, fidelity, and affection in the so-called "dumb animal" much higher than that in the human specimen before him.

A short time since a gentleman of the highest veracity related to me the following, which he personally witnessed: A child fell into a canal. The father's dog was present and immediately jumped in to save the child. As it came up the second time he caught it and kept it above the water. Finding, however, that he could not properly keep it up without some support, he swam with his charge to a beam which crossed the canal just above the water, and, placing his two fore paws upon the beam, rested there and kept the child's head above water till both were rescued.

Now, in this case, instinct or training might impel the dog to jump in after the child, but it would not enable him to adapt himself to the circumstances (new to him) and utilize the beam as he did. This required perception and reason.

It was the late Henry Ward Beecher, I think, who related and vouched for the following: A large and a small dog happened to start from opposite sides of a stream at the same time to cross it over a narrow board which spanned it. They met in the middle. Both came to a stop, for they could not pass each other on the narrow board. The little dog sat down on the board, held up his head, and began to whine. The big dog stood a moment, apparently cogitating what to do, when suddenly a thought struck him. He spread his fore legs apart to the outer edges of the board, also his hind legs, and then looked at the little dog as much as to say, "Now is your time!" whereupon the little fellow shot through between the big dog's legs and safely reached the other side, wagging his tail with delight and approval of so clever a trick; while the big fellow walked philosophically over to his side, no doubt well satisfied with himself, as he certainly had good reason to be.

Dogs, of course, could be trained to do that as well as many other things, but these had not been so trained. The circumstances were new and quite accidental, and the big dog who solved the difficulty had neither the necessary instinct nor training to aid him, but had to fall back on his own mental resources, and he proved himself quite equal to the occasion.

We now come to the honey-bee—last in the list, and the smallest, but by no means the least. Insignificant in size as she is, the honey-bee can put any or all of these other big animals to flight in very short metre! In her marvelous powers of delicate mechanism she can also distance them all, and even cast us in the shade. Hers is one of the fine arts in animal mechanics. As diminutive as she is, she, too, has a brain and nervous system, with ganglions similar to those of the human brain, and with nervous tissue equal to ours in proportion to weight. We need not, therefore, so much wonder that this industrious little insect thinks and reasons, and lays out her work with mathematical accuracy, exercising that exquisitely fine little brain with such extraordinary results. After watching, admiring, handling, and studying the honey-bee for thirty years no one need tell me that this wonderful little creature is void of reason and intelligence and is guided solely by what is called instinct. She, of course, acts much from instinct, as that word is popularly understood, the same as the higher animal does. But new conditions and exigencies arise in which there has been no experience, and where there is, therefore, no instinct adequate to guide. It is then we see unmistakably the exercise of reason in the bee to adapt herself to the new environment.

But the honey-bee, like human beings with reason, makes mistakes; and, indeed, these very occasional mistakes furnish evidence of my contention, for, if the bee were solely guided by an "unerring instinct," she would make no mistakes. Allow me to note here one or two of her natural blunders. A colony of bees left to themselves will, for instance, swarm themselves to death—that is, they will cast so many swarms in the one season that the parent stock is left so weak that it dies in the winter; and the last two swarms cast (say of four altogether) are also so weak and late as to be unable to gather enough stores for winter, and they, too, perish. This, of course, is a great mistake; for, did they swarm but once or twice, all would be strong and in good condition to face the winter. This mistake they make in a state of nature, in a hollow tree in the woods, as well as in the model hive of modern bee-keeping.

I once had a colony which, in the latter part of winter, being dissatisfied with its queen, began to raise young queens to supersede the old one long before there was any prospect or possibility of having drones to mate with the young queen. This certainly was a mistake, as it meant the depopulation and extinction of the colony; whereas the old queen could have carried them safely through to the proper time to supersede her. I may say here, by way of explanation, that when a colony of bees finds its queen failing in fecundity, from age or other causes, the workers, fore-

seeing a gradual depopulation of the hive, set about warding off the impending ill by superseding their mother and queen—that is, by rearing a young queen to take her place. In the case just noted the *object* was all right and the *means* to attain it all right, but, like ourselves sometimes, they were doing their work at the *wrong time.*

A normal colony of bees consists of one queen, some drones—more or less—and from 30,000 to 50,000 workers. The queen is the mother of the whole family—of the workers, the drones, and even her rivals, the young queens, which are to take her place in the hive, and they sometimes dispatch her in superseding her. The workers, as their name implies, do all the work of gathering honey, rearing brood, etc. The drones, like the drones in the human hive, do next to nothing, but do it well, with this difference, that the human drone fails to do well what little he does do.

The conclusion I have reached is this: the horse, the cow, the dog, the honey-bee, and other animals have a certain degree of reason and intelligence as well as instinct, and also have, some of them, strong social and domestic feelings, and are therefore entitled to greater consideration and kinder treatment at the hands of man than they sometimes get. I have also come to the conclusion, viewing the multitude of mistakes and follies of the higher animal, man, that his superior reason and more exalted faculties are not on the whole turned to as good account as the inferior reason and faculties of the so-called "brute beasts."

COLOR IN FLOWERING PLANTS.

By ALICE CARTER.

COLOR is as omnipresent as light. Life, the greatest of artists, uses the most common materials to produce masterpieces which sunset clouds can not surpass. The possibilities of almost infinite color variation are present in every green plant, even in its roots and stems. Appropriate conditions only are needed to bring them out; only power to help in the plant economy can intensify and make them hereditary and permanent. There is little doubt that by careful selection leaves would become as wonderfully variegated as flowers. Indeed, this has been done: some of our cultivated maples—masters of *chiaroscuro*—"are positively rainbow-dyed." Bright-leaved birches, beeches, begonias, and foliage plants are continually improving under man's directive care. These do not appear under natural conditions in our climate, probably because they are of little or no use. Still, there are glorious tree-paintings in our autumn woods. The red of the

dogwood, the yellow of the tulip tree, the brilliant purple of the sweet-gum tree might doubtless be enhanced and modified and made to appear at different seasons by intelligent selection and change of conditions; and travelers tell us that in the tropics, where the struggle for existence is most severe, bright-leaved plants are common. Why? What are the uses of color? Since the publication of the works of Sprengel, Müller, Delpino, Hildebrand, and others, its attractive power has been so enthusiastically studied that the thought of its having other meanings has been largely lost sight of.

Flowers are the hope of a plant; their careful protection from injury is of vital importance. They are, as a rule, so short-lived that there must be special adaptation for the speedy fulfillment of their function. On the other hand, the value of crossing is so great that many of them have become partly dependent for its accomplishment upon the aid of other organisms. But the very provision made for the entertainment and attraction of these friends also serves excellently the wants of numerous intruders who would take the treasure without giving any equivalent for its use. Therefore it is that among flowers (and fruits, to which somewhat similar reasoning applies) we find the most marvelous combinations of attractive and protective qualities, and, as with animals, color is an important element in each. The very beauty which is the Elysian field of some happy insect may be the Gehenna of another. The essentials of a heaven are as varied as individual tastes. Hence it is impossible to limit a given color to one function. Use is many-sided, and while the attractive power must still be emphasized, others should not be forgotten. Color, like everything else, is always increasingly developed in proportion to its usefulness, and accordingly most common and most protean among flowers and fruits, although by no means confined to them.

I. Chemical Uses.—It has sometimes merely chemical uses.

The work of (green color) chlorophyl, the study of which is a science in itself, need not be dwelt on here.

According to Pick, red color, too, has an important chemical office, inasmuch as in its presence the food substances manufactured by young, growing shoots (in which it frequently occurs) are transported more rapidly, so making possible the desired quick development of each organ, while those which are made last do not remain in the autumn leaf to be lost with its fall, but are speedily conducted to the winter storehouses.

Photography shows that color changes the properties of light. Stewart suggests that every flower by means of its color may transform the sun's rays in accordance with its own needs.

II. Protective Color.—The knight of the fairy tale who

started on his quest with shoes of swiftness, charmed sword, and invisible cloak, may well have been one of Nature's models. Many a time since, the invisible cloak has given the victory to her heroes. In the hand-to-hand battle of life, which is continually waging, many an animal escapes unscathed simply by being so like the objects among which it lives that only the keenest sight can distinguish between them. This is "protective coloring." Walking-sticks resemble twigs; alligators, floating logs; brown bitterns, the rocks among which they stand motionless watching for prey; gay birds-of-paradise are almost invisible among the branches of brilliantly blossomed trees. But the phenomenon is not confined to animals.

A remarkable thing about fruits is the great difference *in color* between the dry and fleshy kinds. It is hard to think of a conspicuous dry fruit in all our flora, yet they are far the most numerous; for, of the eight hundred and eighty-nine genera of flowering plants given in Gray's Manual, eight hundred and nine have dry fruits. But many of the eighty fleshy-fruited genera are brightly colored: ten have white, eight yellow, eight yellowish, thirteen blue, twenty-three (usually shining) black, sixteen purple, twenty-five red species. Only four have no other color than green.

Surely this is a significant contrast. There is no intrinsic reason why a nut-shell should not be as brightly tinted as a peach skin, but in the light of modern theories of distribution the problem is simplified. It is now known that dry fruits are disseminated by purely mechanical means, by the agencies of wind and water, or by the unconscious help of animals to whose hair, feathers, or feet they adhere. But fleshy fruits are largely, often entirely, dependent upon animals which eat the attractive and palatable covering, and in one way or another scatter the uninjured seeds. As there are wind, water, and insect pollinated flowers, so there are wind, water, and animal carried fruits; and the first two classes of both are inconspicuous, the third commonly beautifully adorned. The negative reason, then, for the absence of color among dry fruits is the needlessness of attractive characters; but there is a positive and perhaps as powerful a cause which has operated to the same end. Dry fruits are by no means unpalatable. The staple vegetable foods, sought after alike by the lower animals and by man, are grains, legumes, and nuts. In their great popularity is their great danger; their treasure must be hidden. The seeds of many *Compositæ* greedily eaten by birds, are therefore covered; the distasteful or even poisonous fruits of the parsley family freely exposed. The hard shells of nuts, the hairy or bristly coverings of many pods, defeat the attacks of numerous foes. But the charmed bodies of Siegfried and Achilles

did not save them. There never yet was armor without vulnerable point. Nature "arms and equips an organism to find its place and living in the world, and at the same time she arms and equips another to destroy it." Squirrels deftly open the hardest hickory nuts; larvæ penetrate the thickest-shelled almonds. Wallace describes how cleverly the black cockatoo of the Aru Islands breaks into the kanary nut, which is so hard that only a heavy hammer will crack it.

Every little helps, and the absence of the straw may save the camel. Therefore, if in addition to their hard coverings these fruits are also colored so as not to be easily seen, they have still another advantage. Mr. Bailey describes the pods of the sensitive pea as "protectively imitative," much resembling the leaves of the same plant when closed after irritation. Wallace thinks that the dry fruits of herbs "have no doubt often been prevented from acquiring bright colors by natural selection, in order to protect their seeds." And it seems logical that the same purpose may be served by the sober colors of the larger dry fruits.

Fuller describes a kind of figwort as a possible instance of a protectively colored *flower*. The blossoms are inconspicuous and purplish; the ripening ovary develops a dark purple tint, and somewhat resembles the fallen corolla; the buds, too, are as deeply colored as the opened blossoms, an unusual thing. Since this species is adapted to pollination by wasps, and avoided by other insects which have a respectful awe of their formidable sting, the miniature flowers and the fruits seem to be well protected by resembling the blossoms—an economical method to say the least, and so effective that the wasps themselves, sometimes deceived, were seen to alight on the buds and ovaries.

III. Warning Color.—In the forests of Nicaragua there is a brilliant red and blue frog, which is scornfully rejected by the birds who usually devour frogs and lizards greedily. All the other batrachians are protectively colored and feed only at night; but these little fellows hop boldly around with no thought of fear. A certain hermit crab is found always in shells which are covered with a (usually) bright-colored sponge or sea-anemone, both of which are avoided by the crab's enemies. In such cases striking color is correlated with obnoxious chemical qualities, and the enemies understand it.

It would be decidedly advantageous to plants which are not otherwise fitted to survive the attacks of herbivorous animals to accumulate substances offensive to them and then to advertise their disagreeable qualities as clearly as possible, either by peculiar form or color or odor; and what we are constantly learning of the sagacity of animals leaves little room for doubt that they would quickly recognize these species and shun them.

Kerner and Stahl have proved that tannin is distasteful to snails, goats, rabbits, sheep, and cattle. It is therefore not strange that natural selection has brought about the accumulation of this disagreeable substance in organs and at stages of growth needing special protection; and, in fact, it is most abundant in young leaves, flowers, and unripe fruits.

Wigand has shown that red color often accompanies tannin, and it is also true that red-leaved plants commonly contain oxalic acid. Pick suggests that the union of elements of the oxalic acid and of the red coloring matter, resulting in the formation of crystals of calcium oxalate, prevents the formation of such an excess of the acid as would prevent the action of the ferments by which starch is made diffusible. Raphides are bundles of calcium oxalate crystals. Stahl says that the single-pointed crystals which exist in certain irises are an effectual protection against snails, and that in the pickerel weed there are, besides these, raphides and cells rich in tannin—perhaps a suggestion that raphides may have arisen as the further development by natural selection of such solitary crystals. For these delicate, sharp rods are a formidable defense, piercing the skin of a would-be destroyer of the tissues containing them like so many needles. (Taste Jack-in-the-pulpit leaves.)

So there is law in it all. Tannin abounds in plant-tissues. Where it is, red color often appears; and where there is red color, oxalic acid is frequently found; where oxalic acid is, raphides may be formed; and, finally, where there is tannin or raphides or both, there are substances generally disliked by herbivora—a long story, which the red color of the exposed parts of many plants doubtless tells briefly but effectively to their enemies.

For example, various members of the orpine family are not eaten by large animals, because their leaf-tips—the most available parts—contain tannin, "*as shown by their dark-red color.*" Otto Kunze says that the Javanese surround their coffee plantations with a living hedge of red-leaved plants, so keeping off the swine, *which abhor this color.* The brightly tinted leaves of young oaks, maples, etc., are seldom eaten; and in the tropics, where there is the severest struggle for existence, gay leaves are most abundant.

The mottled leaves of arum, lady's-thumb, some everlastings, and prince's pine, and probably of adder's tongue and cyclamen, are protected by raphides; those of begonia have sour, and of coleus and wild ginger, bitter sap. Such variegations of leaf-surface, which may be imperceptible to the larger animals, may have much significance to smaller ones. Species of caterpillars and of beetles are often confined to particular orders or even genera of plants, presumably because, like the cockatoo to the kanary nut, they have adapted themselves to the peculiar characters of these plants,

while kept away from others by effective defenses. (Halicta feeds on the deadly nightshade, which is poisonous to most animals.) I have no doubt that the butterflies, whose wonderful instinct leads them to deposit their eggs upon the plants best adapted to nourish their young, are aided in distinguishing between species and often warned off of the wrong ones by such spots and markings; for they well know how to put two and two together.

The coloring matters of plants are closely connected chemically with the aromatic group of substances (Vines). Naturally, then, odor sometimes takes the place and does the work of color. The presence of distasteful oils, resins, etc., is announced by the odor of some plants no less effectively than that of obnoxious tannin, stinging raphides, or bitter alkaloids, by the colors of others. The most brilliant flowers are not the sweetest; both qualities are not ordinarily needed (though they may exist together, as in the hard-fighting plants of the Mediterranean region); 14·6 per cent of the white flowers are odorous, only 3·2 per cent of the red.* And odor, like color, may be at the same time attractive and repellent—a phenomenon probably much more common than we imagine.

Ten of the thirty species mentioned by Kerner as not eaten by herbivorous mammals are either aromatic or strong-scented. Pasture mints and field onions are avoided by cattle. What hungriest mammal would relish a meal of the skunk-cabbage or the spotted arum? Yet flies are attracted to both. If the offensive odor which some beetles and caterpillars emit when handled is a warning, surely that of these plants says more plainly than words, "*Nemo me impune lacessit.*" Herbivora seem even to be repelled by the sweet fragrance of wintergreen, lily of the valley, violets, and of some orchids, which attracts to them their insect friends.

Again, the same animal may be simultaneously attracted and warned by a color. Dr. Ogle found the white and blue varieties of a species of monk's-hood growing in the same district of Switzerland. Almost every opened corolla of the white variety was perforated; none of the blue. The flowers are dependent for pollination upon bees; the perforated white variety therefore produced no seed, and this form was rare; but the blue, entered legitimately and abundantly pollinated, common. So the importance of the warning is evident. The blue corolla invites guests to the feast of honey, but at the same time proclaims that it is for their interest to get it lawfully. The bees understand that unpleasant properties of some kind are associated with the color of this form.

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* Cruger

Protective organs or substances are frequently increased in the vicinity of flowers. Long ago Erasmus Darwin wrote: "The flowers or petals of plants are perhaps, in general, more acrid than their leaves; hence they are much seldomer eaten by insects." "Many caterpillars will rather die than eat the flowers of the plant whose leaves are their special food."* But insects are not the only foes who steer clear of petals. Kerner gives a long list of plants whose leaves are eaten by herbivora, the flowers untouched. In our own land the blossoms of the waysides and fields—May-weed, buttercups, daisies, dandelions, sorrel, wild carrot, etc.—by their very abundance witness to their immunity from the attacks of grazing animals.† The survival of many showy flowers in St. Helena, notwithstanding the introduction of goats, which have destroyed the luxuriant forests, may perhaps be due to the beauty which brands them unpalatable.

The conspicuousness of all of these species is the noteworthy point. They are landmarks, doubtless, to the lower animals as to us. That blossoms are most completely shunned when they are large and showy is almost axiomatic. If bright flowers tasted well, they would be speedily annihilated. The majority of good fodder plants have insignificant flowers.*

There is still another class of enemies which may be prevented from attacking flowers by the disagreeable chemical properties of their conspicuous petals. These are the birds. Mr. Brockhurst writes that in the dry summer of 1880 the sparrows, seeking pollen, destroyed his crocuses, preferring the yellows to the purples and whites. They also attacked the primroses, devouring hundreds of them in one morning. Orioles have been seen to bite through the corollas of the trumpet-creeper and golden currant. Young seeds and soft petal tissues would certainly seem to be dainty bird-fare, and would surely be more often so used were they not chemically protected from such injury. As things are, however, other food seems to be preferred when it can be found. In addition to the need of defense against rain, and of adaptation to the form and size of the chosen visitors, necessity of keeping the pollen, nectar, and ovules from destruction by birds may have helped in the formation of tubular and palated corollas. Flowers need the beauty of Helen to attract lovers, the guile of Penelope to discriminate between the true and the false; to provide for the one, and against the others.

IV. MIMICRY.—Mr. Bates found in South America and Mr. Wallace in the Malay Archipelago several genera of very abundant, brilliant butterflies which birds refused to eat; and, accom-

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* Kerner.

† The disagreeable substances are volatile, disappearing when the flowers are dried

panying these, a few individuals of rare species, themselves defenseless and palatable, differing widely from the type of the genera to which they belong, and so closely resembling the others as to be readily mistaken for them even by experienced collectors. Since its discovery, numerous examples of this so-called "mimicry" have been brought to light in many classes of animals, its conditions being always the same. A rare, helpless species is protected from attack by similarity, in external appearance only, to a common, easily recognizable, well-defended one.

There are strong resemblances between widely separated genera of plants. The submerged parts of water-crowfoots are much like those of water-marigolds. "It is almost impossible to distinguish between" the euphorbias of Africa and the cacti of South America, when not in blossom; mare's-tail looks like an equisetum—one is a flowering, the other a flowerless plant; the false goat's-beard closely resembles the true; dalibarda "in aspect and foliage resembles a stemless violet." Observation may find proof of some advantage gained to the feebler plant by the likeness in the last two cases, inasmuch as the plants occupy the same localities, and in each case one of the species is much more limited in distribution than the other. But none of the others are examples of true mimicry, because the similar plants do not inhabit the same regions, and it is hardly supposable that any benefit accrues from the likeness. Similarity of conditions may have much to do with it in some instances, but a deeper cause, and one of a kind which we can not yet conceive, must be sought in explanation of the extraordinary results sometimes reached.

Nevertheless, there is true mimicry in plants.

The only South African balsam is strikingly like an orchid which grows in the same locality and is visited by the same insects! Surely a clear case of plagiarism.

The "cow-wheat" is parasitic upon the roots of wheat, whose seed its own so exactly resembles that the two can only be distinguished by careful botanical examination. So the husbandman who himself sows tares among the wheat, one day wakes to say, "An enemy hath done this."

Sir John Lubbock thinks that the harmless dead-nettle may be protected from grazing cattle by its great likeness to the stinging nettle—a member of a widely different order.

In 1833 Robert Brown conjectured that the remarkable insect-like forms of the flowers of the genus *Ophrys* (bee orchid, etc.) "are intended to deter, not to attract insects." But Darwin has shown that some of the species are self-sterile, and all of them are constructed as though insects had played an important part in the shaping of the floral organs. The native home of the genus is the Mediterranean region, where all kinds of methods of defense

are resorted to. Most insect-like orchids resemble brilliant butterflies, which are as a rule unpalatable, and therefore enjoy comparative immunity from attack. May not the flowers be protected by the resemblance, as the defenseless butterflies discovered by Wallace are? Some such reason as this makes it more easy to comprehend the need of such elaborate development for which adaptation to small flies or bees, as in the case of lady-slippers, is hardly a satisfactory explanation. Nature is too economical to spend so lavishly for the accomplishment of what has been done much more simply in other ways. The desirability of combined attraction and repulsion brings with it the need of many new wiles. If "all things are fair in love and war," much may be expected of a man or flower engaged at the same time in both pursuits.

Another orchid (*Pogonia ophioglossoides*) is very difficult to find because of its great likeness to the much more abundant Indian cucumber which lives in the same places. In company with two botanists and a gardener well versed in the ways of the woods, I have spent hours in finding half a dozen specimens. Mr. Gibson, too, met with the same difficulty, actually treading the orchid under foot, "the imitative whorled foliage of the medeolas having beguiled my discrimination." Surely, though, it is the pogonia which is the imitator. It is the rare form, fulfilling all the conditions of mimicry. The two plants dwell together. The rare one differs from its allies; there is no other pogonia, and, indeed, no other orchid of our flora which has its leaves whorled on the stem. The whole appearance of the plant is decidedly non-orchidean, and, so far as pressed specimens show, the flower continues the imitation, for the greatly elongated sepals and three-parted corolla—all green—have decidedly the semblance of the second whorl of leaves always found on the flowering stems of the medeola.

V. ALLURING COLOR.—Color is sometimes a trap.

There is a singular class of beings, half animal, half plant, in their ways of living—a fascinating, uncanny sisterhood—the insectivorous plants, which display marvelous ingenuity in the entrapping of their victims.

The bladder-wort, which abounds in stagnant ditches or ponds, is a member of this class, which has no apparent attractive powers. Yet Darwin says that one species has wonderfully constructed bladders, curiously like an entomostracan crustacean, and, strangely enough, these are the very animals most frequently killed by them.

Pitcher-plants excited the interest of scientists and travelers over a century ago, but the meaning and mechanism of these "plant-saloons" was only discovered within comparatively recent

times. Glandular hairs lead up the margin of the pitcher, and through its mouth to a field of such sugar-plums as grow everywhere in fairyland. Flies, ants, and sometimes moths, follow the baited path to feed on the sweets. But getting out is not so easy as going in. Some, reaching the limit of the sugar grove, slip on the glassy surface which is below it; others, satiated with the honey, try to fly away, but are dashed against the opposing lid of the pitfall, fall back into the tube again, and at last they, too, slip from the middle walls to be drained and more or less completely digested by the fluid secreted from myriads of hairs at its base.

The lure of the allied genus, *Darlingtonia*, is still more perfect. The singular, orange-red, fleshy, two-lobed organ which hangs over the pitcher's mouth much resembles the flower of the same plant, so that visitors which normally pollinate that may be betrayed by the double deceit. This is curiously like Stewart's description of an Asiatic lizard whose body is protectively colored like the sand on which it lives, but at each angle of the mouth a fold is produced into a shape "exactly resembling a little red flower which grows in the sand." Insects approach and are captured.

The elongated, hollow leaf-tips of Nepenthes have the same general purple coloration. The shade of many an insect which has perished in such a drunkard's grave emphasizes the "touch-not, taste-not" law—"he that is careless in his ways shall die."

The sparkling glands of the sun-dew, pinguicula, and Venus's fly-trap are scattered over the flat leaf-blades. A Portuguese genus is called by the villagers "the fly-catcher," and hung up in their cottages as such. A single plant of martynia, about three feet high and as many in diameter, caught seven thousand two hundred small flies. The abundant hairs secrete an exceedingly viscid fluid, whose unpleasant odor comes to the help of color. The disagreeable smell of *Arum crinitum* also draws many small flies to its spathes, from which escape is made difficult by the sticky downward-pointing hairs of their inner surfaces. Some of the visitors, unable to make their way out, die and are apparently digested. Others crawl up the spadix and fly away to deposit pollen on the stigmas at the base of the next spathe which they enter and in which they will probably die in their turn. So, as perhaps in Darlingtonia, one insect serves two important purposes. "Thrift, thrift, Horatio!" The priests themselves furnish forth the meats of the marriage-tables.

The prevailing colors of the attractive parts of all these plants, with the single exception of the bladder-wort, are the same that we shall find again in fly-pollinated flowers. The lurid red, purple, or pink of the pitcher-plants, sun-dew, etc., recall the blossoms

of Dutchman's pipe, Bryophyllum, and Cirrhopetalum, and the spathes of the skunk-cabbage; the glittering, dew-like drops of butterwort and the unicorn plant occur again in the false flower-glands of Parnassia and the deceptive, sparkling ovary of Paris; and that disagreeable odor is a common characteristic in both classes strengthens the belief that in both carrion-loving flies (or beetles) are the objective points of the attraction, with this unessential difference that in the one class the plant feeds the flies, in the other the flies feed the plant.

VI. ATTRACTIVE COLOR.—Leaving aside the negative evidence derivable from cleistogamy and the existence of only inconspicuous flowers in places where insects and flower-frequenting birds are absent, it remains to prove that attractive qualities actually have reference to the visits of animals, thereby establishing their usefulness—i. e., their eligibility as characters upon which natural selection may work.

Where there are bright flowers there are color-minded animals. All orders of insects are represented to an altitude of 2,300 metres, butterflies, flies, and certain bees even to 4,600 metres. The number and kind of insects are in close relation to the number and kind of flowers and their hours of waking and sleeping. Climate affects the color of all parts of a plant. Cereal grains are said to be brighter in the North. Fruits are invariably so. Many travelers have observed the intensity in the color of Alpine flowers up to certain limits of temperature. But if the brighter color is useless it will not be retained after a few generations, as the inconspicuous character of the flora of insect-poor Greenland shows; if serviceable, it will be not only preserved, but deepened as time goes on. The absolute number of flowering plants decreases with increase of latitude or altitude. As men flock to cities until the average compensation becomes equal to less than what they can obtain in the country, so all insects would stay on the plains or in the tropics until their number, becoming disproportioned to that of the flowers, better rewards can be obtained in less crowded regions. To this interdependence of insects and plants, and to the constancy of the numerical relations between the two, inherited intensity of color must be largely due. If the insects are greatly in excess of the attractive flowers, inconspicuous and conspicuous blossoms would be searched and fertilized alike in the resulting scarcity of food. If the number of flowers is much larger than that of the insects supported by them, the latter, becoming fastidious, frequent only the brightest or more fragrant, neglecting the others, which accordingly remain inconspicuous and self-fertile. When both insects and flowers are scarce, the former will remain only so long as the greater attractiveness of the latter makes it as easy to obtain the same amount

of honey as could be obtained in the same time from the flora of richer regions where competition lessens the rewards of labor.

It is, therefore, necessary that the insect-dependent plants of colder places should have special attractions, and they do. Observations prove that one or more of the three qualities—color, nectar, and fragrance—which attract visitors are naturally increased in Alpine and northern plants, and it is not strange that some insects have been persuaded to leave all and follow these into their colder homes.

McLeod in the Pyrenees, Delpino in Spitzbergen and Nova Zembla, Müller in the Alps, and Verhoeff on the island of Norderney, all concluded that, in correlation with a scarcity of certain classes of insects, the flowers are either more conspicuous, or there is a noticeable increase in number of wind or self fertilized forms.

That climate alone can not account for the lack of beautiful flowers in countries where flower-visitors are rare, is the more evident in the comparison of the weedy flora of Tahiti with the rich one of the neighboring Sandwich Islands, or with that of Juan Fernandez, in both of which honey-sucking birds abound.

Again, there is proof of the actual preference of the different groups of insects and birds for particular kinds and colors of flowers.

The richest and gayest flowers of the world are those of temperate Australia, South Africa, the south European Alps, and South America. Honey-suckers abound in the first (are found nowhere else in the world); most of the sun-birds of the world are found in the second; humming-birds are almost exclusively confined to the last; butterflies and bees characterize the third.

Large, bright-colored, scentless flowers seem to be the favorites of birds and butterflies.

Riley says that "white moths are naturally attracted to white flowers." The difference in color between flowers visited by night-flying moths and by butterflies is very instructive, showing that something more than absence of light has led to the general colorlessness of evening blossoms (compare the day and night-flowering species of lily, etc.), many of which are fragrant, keeping "their sweetness to themselves all day," to "let the delicious secret out" under cover of darkness. So fragrance does the work of the honey-guides which are invariably lacking in evening flowers. Since many of these remain open only a short time—one, two, or three nights—it is the more important that they be easily found by the keen sighted and scented friends, to whom fragrance is as sure a guide as color.

But of all insects, the females of the social bees take the leadership in horticulture. They are the most useful and in-

dustrious of flower-guests, because they provide not only for their own needs, but also for those of their numerous progeny. Many of them are wise systematists, as Aristotle noted long ago, who wrote, "A bee on any one expedition does not pass from one kind of plant to another, but confines itself to a single species and does not change until it has first returned to the hive." Color must help them much; but since they visit a great variety of flowers, it is seemingly most useful as a means of distinguishing intermixed species, one color, in itself, being perhaps little more attractive than another.

Kerner, Kronfield, Forbes, and Della Torre have seen bumblebees fly for hours from one flower to another of the same kind, ignoring other species which grew mixed with them. To such persistent and intelligent industry our field and meadow flowers, at least in part, owe their endless variety of shape and color, and as long as bees live there will be fresh modifications for us to wonder at. The "soft sun-brush" directed by the exquisite taste of these little connoisseurs of true art is continually producing new *chefs-d'œuvre.*

Nor is the work of flies to be despised. Some of them are almost as enterprising and have apparently as keen a sense of beauty as many bees and butterflies. Müller speaks of the largest and most handsome of the saxifrages as the "masterpiece of the *Syrphidæ*" (the most highly developed of flies). Fly-flowers have often dark-red color and nectar so scanty that it does not pay the bees to take it—e. g., bryophyllum. In New Zealand flies largely take the place of bees, which are there exceedingly scarce. Some species are exclusively dependent on them. Lurid, snaking spots or markings or disgusting odors often tell the secret of fly-attraction (arum, Dutchman's pipe, skunk-cabbage, smilax).

But some flowers, neither showy nor fragrant, are yet abundantly visited both by bees and flies (bryonia, bur-cucumber, etc.). Kunth found that the greenish petals of some of these plants affect a photographic plate as strongly as those of white, violet, or blue flowers. It is not at all unthinkable that the wonderful eyes of insects may be sensitive to colors invisible to our coarser sense. Kunth adds that the glands of these plants may perhaps contain ethereal oils noticeable to insects though imperceptible to man.

Surely, in the face of all these facts, it can not be denied that there is some relation between the conspicuousness or fragrance of flowers and their pollinization and pollinizers, especially since it is possible in the various insect groups to trace a connection between the two, and since, in the absence of animals of one kind, others have sometimes been delegated to do the work, the botanical character of the region changing correspondingly; as, for

instance, in the fly-flora of New Zealand and the bird-flora of Juan Fernandez. Indeed, M. Sevali claims that grasshoppers fertilize the *Leguminosæ* of New Zealand, and Delpino thinks that *Rhodea*, which is self-sterile, depends for the production of seeds upon snails!

In order that the selection of insects may cause change in the characteristics of flowers, two things are necessary on their part. Their visits must be methodic—we have seen that they are so for the most highly specialized groups. They must be frequent. Any one who has followed a "busy bee" for half a day will be ready to witness that they are. A bumble-bee in mid-Sweden was seen to suck honey from the monk's-hood at the rate of from 960 to 1,200 visits an hour; a butterfly visited 194 violets in six minutes and three quarters; 2,155 bees were actually counted on a single head of the "honey plant" between 5 A. M. and 7 P. M., the thirty heads of one plant furnishing supplies for over 64,000 bees in one day. Some one has calculated that 2,500,000 visits are made to the red clover for every pound of honey. The United States, by the census report of 1880, produced 25,743,208 pounds, representing, therefore, 64,358,020,000,000 visits of *hive-bees alone in this country*, and this includes only that used for economic purposes, not at all that kept by the bees themselves. Add to these visits those of the wild bees, bumble-bees, flies, butterflies, birds—which are by no means indiscriminate—and surely here is a force whose selective influence must be enormous, which might easily bring about a comparatively rapid evolution. May not this shed some light on the mystery of the rapid floral development of *Phanerogams* after their initiation in geologic ages? Gardeners and farmers have, in relatively short time, been able to introduce and establish new forms of flowers, fruits, and grains, but the results of the industry of this vast army of workers must have been inconceivably larger.

This brings us to the other side of the question. Something is necessary on the part of the flowers, which must themselves be capable of great variation in color and form in order that selection may have material to choose from. Every one knows that they are so. As the latest production of the vegetable world they are the most plastic, the most easily influenced by alterations of the environment. (Old traits are not easily changed.) Many of them in their individual development pass through a series of changes which sometimes, perhaps, represents the color phylogeny of the species—e. g., several species of honeysuckle are white the first day, become yellow the second, wither the third. A certain hibiscus is white in the morning, rose-color during midday, and red in the evening, repeating these transformations each day as long as the flower lasts. Such changes are supposed to be

merely chemical, the oxygen accumulated by night being used up by day.

But the most quick-witted insects would notice them, and we find that some plants have adopted them as dialects of the universal "flower-language." Fritz Müller describes a Brazilian lantana whose flowers last three days, and are yellow the first, red the second, purple the third. A few butterflies stick their tongues into the yellow and red, others visit only the red, none the purple. If the flowers fell the first day, the inflorescences would be less conspicuous; if the butterflies did not appreciate the change, they would lose time in searching for honey from old, functionless nectaries. What may be a purely chemical phenomenon in the hibiscus has become a constant and useful character. (Even more remarkable is the case described by Hildebrand of *Eremurus,* whose flowers open before the reproductive organs are mature. After the corolla is withered, stamens, stigma, and nectaries become fully developed, so the less intelligent insects, decoyed by the bright young flowers and finding there no honey, leave the inflorescence to the friends who love it because "it has opened its heart" to them.)

Tannin, which causes the disagreeable taste of many petals, is peculiarly abundant in cells which exhibit irritability—i. e., it is easily affected by outside agencies. Petals are delicate organs, and whatever irritable substance is in them is therefore the more easily stimulated. Add this to the fact of their youth, and it is natural that flowers should be pre-eminently variable, and altogether possible that certain stages may be seized upon and made hereditary by the selection of the innumerable army of hungry insects.

So, again, there is law all the way through. The operation of entirely natural and conceivable causes leads to the permanent establishment and combination of colors, odors, and forms which may be protective, repulsive, imitative, attractive, or unite several of these functions. And in the "continuous adjustment of internal to external conditions" is the evolution from alga to rose, which shall by no means stop with the rose. The song of the flowers is clear and true:

> "So on our heels a fresh perfection treads;
> A power, more strong in beauty, born of us
> And fated to excel us, as we pass
> In glory that old darkness;
> —For, 'tis the eternal law,
> That first in beauty shall be first in might."

MODERN NERVOUSNESS AND ITS CURE.

By Herr Dr. BILSINGER.

THE signature of our age is a thin-blooded, nervous generation. Only a few decades ago our women were so healthy that they were able to suffer occasional bloodlettings to counteract a supposed excess of blood. Now our girls are pale even in their school age, and the general complaint is that the girls are nervous. Not without reason is the age called a nervous one. While our ancestors, living in natural conditions, hardly knew what nerves were, we complain of excited nerves, even among our children; and adults, especially in the cities, who do not suffer from nervousness are exceptions. There is no doubt that weakness of the nerves, or neurasthenia as the doctors call it, is an acquisition of modern civilization, and at this time, or since attention was called to it by the American George M. Beard, as being as it were a new disease, is playing a formidable part with doctors and laymen.

The term neurasthenia does not so much signify a special affection of the nervous system as it is a fittingly chosen general name for a whole group of disorders the character of which consists in the nervous system failing to act properly, on account of a deficiency of normal nerve-substance. Such a condition, or at least a pronounced tendency to it, is in many cases inherited from parents; and only slightly unfavorable circumstances are required in children thus hereditarily tainted for the development of pronounced neurasthenia. There is, besides the hereditary form, an acquired weakness of the nerves, which may be produced by a considerable variety of causes. The blame for the present condition of our society undoubtedly lies in the haste and pressure of the age, with its battle for existence, driving us into morbidity. The increase and crowded condition of lunatic asylums speaks with admonitory plainness in this matter, and it is time that the right meaning was attached to the momentous phenomenon. Even in the country, where the hygienic conditions are relatively favorable, the evil of nervous weakness is gradually making itself more plain. It is conspicuous in the larger cities, where, with the meeting of great masses of men, the clatter of railroads, and the driving of factories, excitement prevails through day and night, under which the afflicted nerves with great difficulty obtain the rest they need. To this haste and excitement in social life are added the schools with their augmented demands, the trial of examinations, and modern business life; and it is no wonder that only a small fraction of the population escape these attacks on the nervous system.

Our general social conditions, in which the ease that once prevailed is approaching nearer and nearer to extinction, undoubtedly have a great deal to do with the preponderance of nervous diseases.

On the other hand, it can not be too impressively insisted upon that the individual has the means to a certain degree in his own hands of alleviating by a rational mode of life the general harm to which modern man is exposed. But it has to be remarked that the greater number of us, in spite of all the instruction we get, remain in incredibly dense ignorance of matters of personal hygiene. It thus occurs that many allow themselves to be guilty of sins against their own personality by which the health of their nerves is broken to the very marrow. Besides overwork on the one side, there are certain special indulgences, abuse of spirits and other stimulants, too early and excessive tobacco-smoking, and in the majority of cases all together, by which the nervous system is at last disordered and severely injured in its vigor. I was told by an officer that he began to smoke in his twelfth year, and when he marched to France as an ensign he now and then smoked ground coffee when he had no tobacco. It is not to be wondered at that this officer became insane a few weeks after his marriage, and had to be put in an asylum. In other cases there are more or less self-accused disillusions, cares, sorrows, and similar mental conditions, through which the nervous system is weakened and thrown off the track.

Through all these processes waste products are formed in the body, which, acting as self-poisons, cause more or less disturbance in the nervous system. In consequence of the storing up of these self-poisons, patients complain of sleeplessness, nervous pains appearing here and there in diversified alternations, and of being easily fatigued after brief mental or bodily efforts. They are often cross, overcome by trifles, and very frequently complain of nervous disturbances. Nervous dyspepsia is therefore in many cases associated with neurasthenia.

Sadly numerous as such cases of neurasthenia appear at this time, our knowledge has advanced so far that we can, with good heart, give promise of comfort and courage to nervously afflicted persons. For, even in apparently critical cases, a surprisingly favorable result may be reached by the exercise of a little patience combined with a proper and intelligently directed general hygiene. I sincerely advise nervous patients to avoid, as much as possible, all drug remedies. Especially would I warn them against habitual use of benumbing narcotics, however seductively they may operate at first. In my opinion, all these means ultimately do more harm than good.

Of immensely greater value than drugs to nervous patients

are the natural factors of healing—air, light, water, quiet, exercise, etc.

The first thing required is, of course, to remove the fundamental causes of the disease. As much rest as possible should be given from without as well as from within; a true religious condition, which a sure faith gives, is therefore of inestimable value to patients. It is self-evident that they must try to be, as much as possible, in the open air, and mountain air is particularly advantageous to them.

Extravagant as they may venture to be in the enjoyment of fresh air, they should be more careful against excessive applications of water. They should always remember that man is not a water animal but an air animal. If in anything, a close adaptation of the treatment by the physician to the individual is particularly necessary in respect to the treatment of nervous patients with water. By the abuse of water in nervous diseases that most sovereign of all remedies has, after a short period of popularity, come into discredit. It is certain that a too indiscriminate application of water is a double poison to nervous patients. It is, on the other side, incontestable that water applications in the right measure, and in a manner adapted to the character of the affection, are excellent. Equally advantageous for them are going barefooted when properly prescribed, and the air-bath. In connection with the water and air cures certain respiratory and muscular exercises are advantages, and may, in certain advanced stages of the disease, be applied passively by massage and similar operations. Among other things, gardening and other occupations in the open air are of great benefit. Unhappily, in the large cities, where the majority of the patients live, there are only a few so fortunately situated as to be able to enjoy such employment to any considerable extent. Those who are able to go clear into the country, and work in the fields and woods in the sweat of their brows, will perhaps, if they are prudent and other conditions are favorable, effect a happy cure of their nervous disorders.

Those who have no garden to till will have to depend on gymnastics as a substitute. Among the simplest and most convenient exercises of this class are those with an instrument called the arm and chest strengthener, of a German manufacturer. The apparatus is handy, cheap, durable, and adapted to a variety of exercises. Further, the resistance of the weights can be easily measured and regulated for each patient, while the operation is in other respects the same. With this little apparatus we can safely produce expansion of the chest, regulation of the activity of the heart, and strengthening of the muscles. With it the metabolism and blood formation are materially assisted in a natural way. The little

home apparatus is therefore not only of great advantage to nervous patients, but it can also be used profitably as a prophylaxis against tuberculosis; it fortifies the chest and strengthens the whole constitution. Care should be taken to perform the exercise in a well-aired room, and not to carry it to excess.

A suitable diet, specially adapted to each case, is of great importance in all nervous disease. The best general diet is usually one that is a little stimulating and blood-forming, with frequent changes. The usual courses of meat and wine should be considerably diminished, else the nerves will not be able to get the rest they need. Besides albuminous food, the necessary quantity of nutritious salts should be provided in supplies of fruit, green vegetables, and suitable milk and grain dishes. Very much to be recommended in nervous disorders are a well-prepared dish of oatmeal, a strong soup, or other dish of the kind. Such light food will not indeed be relished by many because of its being too contrary to their former habits. In such cases some savory addition to the cereal food may be a desirable expedient.

The old German acorn coffee is of special value in diseases of the nerves. Unmixed it is not very palatable to civilized men, but preparations may be made of it which will be found very useful in cases of nervous dyspepsia.

A suitable mental treatment should go hand in hand with hygienic and dietetic measures if the most favorable results are to be secured. Patience is a particularly valuable medicine to the neurasthenic; for it is evident that a disordered nervous system can be brought into equilibrium only with time and with the requisite endurance. In other respects the patient must try to contribute force to his cure through self-control, through strengthening of his will, and through bringing his mind up to a proper tone. The word of the poet comes into force that "time is man's angel." For the cure of even serious cases may be hoped for by following the hints we have given above; a corresponding right application of Nature's healing factors may bring about speedy cures even in apparently hopeless cases.

For the modern world, as a whole, the essential thing to be done is to return to ways of life more harmonious with Nature and less vexing to body and soul. The way to do this is clearly pointed out in the teachings of modern hygiene. May society enter upon this way betimes, for its own good and the salvation of the future!—*Translated for The Popular Science Monthly from Ueber Land und Meer.*

"THEORIES," said Prof. William Rutherford, at the British Association, "are but the leaves of the tree of science—they bud and expand, and in time they fade and fall, but they enable the tree to breathe and live."

THE FIRST GERMAN PAPER-MAKER.

By EDUARD GROSSE.

"IN the name of Christ, amen. Anno Domini 1390, I, Ulman Stromer, started at making paper on St. John's day at the Solstice, and began to set up a wheel in the *Gleissmühle*, and Clos Obsser was the first who came to work."

So said Ulman Stromer, undoubtedly the first German paper-maker, in his notes which are still preserved. Five hundred years have passed since then, and the art of paper-making can look back on as long a period of earnest effort and profitable work. When Ulman Stromer so long ago established paper-making in Germany he had no foresight of the important position paper was destined to assume in the civilization of man. In book-printing, and outside of it, it is the most efficient agent in the advancement of the race, and has become a supreme necessity. It is the foundation of the book and newspaper arts, the indispensable aid of science and instruction, as well as of commercial and social intercourse. In short, it so governs our whole age that hardly anything could be thought of without paper in its present shape.

It was different in Ulman Stromer's time. Paper was then a rare material, little used, and only to be found in the offices of the learned, of scribes, and of officers. The supply of Germany and of all northern Europe was brought from Italy and Spain, most of it from the factories of Fabriano in Italy, where paper-mills existed in the twelfth century, while a lively paper industry flourished in Spain, with its principal seat at San Felipe in Valencia, as early as 1150. The paper-making art was introduced into both of these lands by the Arabs, who learned it in Samarcand and spread it through Europe. It was introduced into Samarcand in 751 by Chinese prisoners from their country, where it had been carried on from extremely ancient times. It is believed that the Chinese were making paper at the beginning of the Christian era, while the civilized lands of the West had still no other writing material than the Egyptian papyrus, which was not equal to the Chinese paper in quality and serviceableness, and parchment prepared from skins, the high price of which prohibited its general and free use.

The mercantile houses of Germany had trade relations with Italy at an early date. German merchants made trading journeys there, and sent their sons to Italian universities, or to Venice and other marts to learn business. We must therefore suppose that the paper-maker's art was not wholly unknown to the Germans, and that individual dealers had had opportunities to visit

paper-mills on their journeys to Italy, even though they may not have had a real knowledge of the art. In any case it is not impossible that enterprising men of business had even before Ulman Stromer conceived the plan of establishing paper-mills with the help of Italian workmen; for the expense of transporting paper across the Alps must have made it very high, and there was abundant prospect of making the enterprise profitable in the fact that there were no paper-mills north of the Alps except in southern France. We are, in fact, inclined to believe that a few paper-mills existed in Germany at the end of the thirteenth and the beginning of the fourteenth centuries. Thus, the paper on which

FIG. 1.—ULMAN STROMER'S PAPER-MILL. (From Schedel's *Buch der Chroniken* of 1493.)

the copy of a document of 1315 is written is a specimen of the German Holbein's paper, for it bears as a water-mark an ox's head, which, according to Gutermann, was the arms of the Holbein family, whose paper-mill was standing at Ravensburg, according to some in 1270, according to others in 1324. But the fact that the Fabrianos also worked a similar water-mark into their paper bears on the other side. It has not been possible to prove that the Holbein paper-mills were in operation before the year 1407, when the first authentic mention is made of a paper factory at Ravensburg, and of the paper-makers Cunrat, Peter, and Stengli. There were also paper-mills about 1347 at Au, near Munich, and in 1356 at Leesdorf in Lower Austria; but documentary evidence to

establish the fact is as defective as it is of the early existence of the Ravensburg mills.

But it is incontestably established that the Nuremberg Ratsherr Ulman Stromer built a paper-mill in 1390, which was the first demonstrably in Germany. Through his carefully kept notes many particulars of Ulman Stromer's life and business transactions are known to us. They furnish information concerning the introduction of paper-making, and further permit a deep insight into the conditions of trade and industry at that time. A happy chance has also permitted the picture of Stromer's paper-mill to come down to posterity, and we contemplate with pleasure the rude drawing that represents the high-gabled buildings of this German factory of five hundred years ago. The view (Fig. 1) is reproduced as exactly as possible from Hartmann Schedel's *Buch der Chroniken* of 1493, which was printed by Anton Koburger and illustrated by Michael Wohlgemut and Wilhelm Pleydenwurf with about two thousand woodcuts.

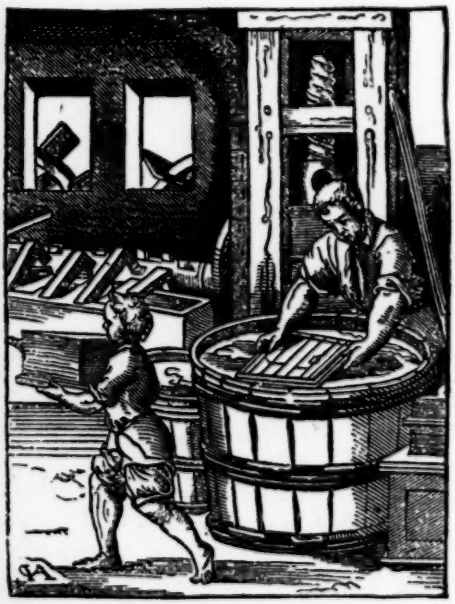

FIG. 2.—INTERIOR OF AN OLD GERMAN PAPER-MILL. (After Jost Amman, 1568.)

Ulman Stromer, born on the 26th of January, 1329, was descended from a distinguished Nuremberg family, whose ancestor, Conrad von Reichenbach, having married into the family of the Wàldstromers, resided thenceforth in Nuremberg, and called himself Stromeyr, abbreviated into Stromer. He became a man of extensive business and considerable wealth, and the owner of houses in the city and of a landed estate, and eventually one of the most prominent men in Nuremberg. With a brief interruption he sat in the city council, and was for a long time one of the three chief magistrates. In this capacity he often represented the city in important transactions, and served as its plenipotentiary in foreign affairs, as, for example, in the conclusion of the accession of Nuremberg to the Swabian Confederacy. Ulman Stromer often made long journeys in the interest of his business. Like other great dealers of Nuremberg, Augsburg, and the Tyrol, he was

probably an intermediary of trade between the southern and northern countries. In his journeys to Italy he became acquainted with the paper-mills, and observing the prosperity of the Fabrianos, Cividales, and Battaglias, recognized the immense importance of the trade. It was a short step to decide to establish a paper-mill at home. There being no paper-makers in Germany, he secured the brothers Marco and Francisco di Marchia and their boy Bartolomeo in Italy and brought them to Nuremberg. He built his mill in the so-called *Gleissmühle*, which was situated not far from Nuremberg, near the present Hallerniese. Whether he built a new mill or only adapted an old grist-mill or oil-mill, of which we know nothing, he had to prepare new machinery for paper-making, including stamps, presses, and tubs, and sorting and drying rooms. Notwithstanding these apparatus were of the simplest character, their construction required considerable time, for work was done more slowly in those days than now. When, therefore, Stromer reports that he began paper-making on St. John's day, we must suppose either that months or years had been spent before that in hard work, or that he did not begin the actual making of paper, but only the building of his mill, on that St. John's day. The latter seems, in fact, to have been the case, for Stromer says that it was then that he set the wheel—that is, the water-wheel by which the stamping machine was propelled.

The view of the interior of an old German paper-mill in the year 1568 (Fig. 2) is taken from a woodcut by Jost Amman. In the left background are seen through the window the paddles and upper part of two water-wheels, which, moved by the stream without, drive the works within, especially the large roller that lies against the wall. This, it may be seen, is furnished with projecting beaters which are designed to hit upon the knee-bent stamps visible in front, and work them up and down. The heavy stamps lie with their hammer-shaped ends in a rectangular trough, in which the rags are placed after having been cut up and macerated. These stamps, with their heavy blows on the rags, beat them till the cloth and its threads are resolved into a fine lint, which, bleached, washed, and mixed with an adhesive substance, are carried, a semi-fluid mass, into the draw-tubs. The paper-maker draws the pulp from them with a rectangular metallic sieve, and, while the water is dripping out through the meshes in the bottom, he shakes the fibrous mass that is left till it lies smoothly on the wire-work, felted into an even, homogeneous leaf. This is the still moist paper, which now laid between felts is placed in the powerful press that is seen behind the workman, and freed from water and made smooth. When this is done, the sheet is taken out of the press, carried in piles by apprentices to

the drying-ground, there hung on lines, from which it is taken when dried and is then smoothed again. Such in brief outline was the method of the old paper-makers, which has now, of course, been greatly modified and substantially supplanted by the invention of paper-making machinery. Stromer's first assistant, Clos Obsser, was probably not a skilled paper-maker, but a carpenter, who came to fix the water-wheel, while the real paper-making could not be begun till this was done and the stamps were in working order. This was apparently in August, 1390, for on the 7th of that month Stromer swore his assistant Clos Obsser to fidelity and to keep the secret of the art of paper-making, as he did regularly afterward with all his workmen when they began.

The pledge of assistants to secrecy was an old custom which was observed in different trades. It was particularly usual then when working methods were still little known and assistants initiated into the secrets might, by means of their knowledge, injure their employer by inducing an unwelcome competition. Such a danger lay before the Stromer mill. There were as yet no paper-makers in Germany. The process was known only in the southern countries, and Stromer, as a substantial business man, desired to prevent his workmen revealing the secrets of the art or setting up competitions. He therefore made himself secure by an oath from his men and by written contracts. He administered an oath of this kind in the presence of his son Jörg to Clos Obsser on the 7th of August; and a few days later to another workman named Jörg Tirman, recording the fact in a note: "Anno Domini 1390, on the day after St. Lawrence's day (11th of August) Jörg Tirman gave me his pledge, and swore with upraised fingers an oath to hold his trust, to be true to me and my heirs, to further our advantage and keep harm from us, truly without any comrades. He is for ten years to engage in no work in paper-making except for me or my heirs, to whom I leave the paper-mill; and when the prescribed ten years have passed, he may make paper for himself but not for anybody else. For this he has a permit from my own hand." Stromer imposed a similar oath on the Italians Marco and Francisco di Marchia and their boy Bartolomeo, and added the provision that they should not give either advice or help in the introduction of Italian paper-making in any countries on the hither side of the mountains of Lombardy. A copy of the oath was made, attested by five witnesses, and given to each of the parties. He doubtless made a good business out of his paper, for he could sell it at great profit, while the rags and other raw materials, not being yet currently merchantable articles, could be bought very cheaply. He did not lack for customers, but was, on the contrary, not able to supply the demand of Germany or even of central Germany; for it appears, from various

account-books, that much paper was still brought in from Italy, and that even the Council of Nuremberg was obliged to obtain a part of its supply there. Therefore Stromer planned an enlargement of his mill, and decided to add to the two wheels driving eighteen stamps a third. In this enterprise he had an opportunity to become acquainted with the worse side of the character of his Italian paper-makers. It did not escape them that Stromer's paper-mill was profitable, and they observed its rapid rise with much dissatisfaction. They tried to get the mill into their own hands under favorable conditions and to enjoy the profits. They sought to reach their object by artful means, throwing every obstacle in the way of his business, and making it unpleasant for him. They neglected their work, did not make the best use of the stamps, and made less paper than they might have made. Under the pretext that they could not do the work alone, they asked him to send for a few more of their countrymen; and when he declined to employ more Italians, they summarily refused to permit the third wheel. When they thought they had tired their employer out, they broached their own plan. They proposed that Stromer should lease them the mill for an annual rent of two hundred gulden. When this was not accepted, they offered him a certain quantity of their own made paper as a rent. This proposition was also declined; the disappointed Italians carried their false play to the extreme, and gave their employer all the trouble they could.

He at last lost patience. He seized the Italians, put them in the tower "behind the drying-kiln," and locked them up, as he says, "in a little room." They were not pleased with their quarters in this "little room," and, giving up their spite, they sent on the fourth day of their imprisonment for the three citizens, Hans Groland, Stromer's brother-in-law, Fritz Amman, and Ulrich Stremler, to negotiate for them with Stromer. He was disposed to conciliation, and it was agreed that both sides should pledge themselves to observe honorably all that should be ordered by the referees. The Italians were liberated, and all went to the Augustine Convent, where the agreement was ratified anew. The Italians had to swear a new oath that they would in future be absolutely true to their former oath, and they would not try to harm by word or deed any one who had been accessory to their imprisonment; that they would have no contention with the master, Ulman Stromer, his family, and servants, otherwise than in the courts of Nuremberg; and that they would interpose no obstacles in the way of their employer and his heirs, and that they would perform what he ordered, whether it were to have one, two, or three wheels in the *Gleissmühle*, or to set them up in another place. After Stromer had thus brought the Italians to

terms, he seems to have had no further trouble with his people. The business went on quietly with a steady increase. New workmen were employed every year; and in 1398 seventeen men were employed there, with three women to sort rags, and a bookkeeper. These were all sworn in as solemnly as the first workmen. Among the later hands were three carpenters, each of whom received fifteen pennies a day. A comparison of these wages with the price at which paper was then sold—about forty groschen a ream for writing-paper in 1426—suggests that Stromer's profits were exceedingly large. There was no competition so long as he lived, and his mill continued to be the only one in Germany, a fact which may be ascribed to his careful proceedings in hiring workmen. The year of his death, 1407, was also the year of the beginning of the second authenticated paper-mill, at Ravensburg, which is then first mentioned in the records of the city. A paper-mill went into operation the next year at Strasburg, and others at Liegnitz in 1420, Basle in 1440, Bautzen in 1443, and Augsburg in 1468; after which, the art of printing having been introduced, the demand that arose for paper caused factories to increase very rapidly. There are now in operation in Germany about nine hundred and twenty-five paper-mills, which produce more than 400,000,000 kilogrammes of paper a year.—*Translated for The Popular Science Monthly from Daheim.*

ARE BUSINESS PROFITS TOO LARGE?

By J. B. MANN.

THERE are four essentials to any successful business—viz., capital, labor, skill, and opportunity. The first three of these must be paid, and our question relates to the proportion of compensation to be awarded.

We must start by considering the circumstances of the case. If we take an ordinary country village, we will find several boys with the capacity to labor, but without capital and skill to conduct a large business, and from necessity they become laborers. Then we find two or three perhaps with business ability, but no capital, and if they can not borrow capital—and most of them can not at first—they become laborers also. Occasionally one is found like W. H. Vanderbilt, having both capital and skill, and he steps to the front and does business enough, or more than enough, for several villages. His wealth increases rapidly, and his power to accumulate gains all the time.

Now the laborer looks at Vanderbilt as a capitalist chiefly, and knowing that labor is just as essential to business as capital,

naturally asks why it should not be as well rewarded. The answer always must be that it should, but this does not answer the main question as to the proper proportion of profits to be divided. Three things being essential, and each able to command pay, the portion of pay must be governed by circumstances. In the case of our village boys, one only can start in business, and nine start as laborers, so that there are in the beginning nine competitors for the rewards of labor, and but one for the rewards of both capital and skill in management. On the law of competition, which can not be evaded in the long run, this seems to put labor at a great disadvantage, but it is a disadvantage imposed by Nature, and so need not be discussed. The actual fact is, that there are three things equally essential and to be paid for the conduct of business. If we had thirty dollars to divide as the result of an enterprise, and should say that, as all three of the things were essential, each of them must have a third of the emolument, we would shoot wide of the mark. In that case, one individual would get twenty dollars, and nine would get only one dollar and eleven cents apiece. That would be absurd. But the poor man, looking to the owner of a hundred millions, imagines that the division has been something very much like it.

The poor man, however, is mistaken. There is no business of recognized legitimacy that pays labor only a third. There is no business that gives to capital and skill combined even ten dollars out of thirty. Labor gets more than two thirds of the income of most undertakings, and of many gets the whole, while the entire capital not only obtains nothing, but is itself lost in the venture, and its owner relegated to the ranks of labor. No man, employing ten hands at wages of three dollars per day each, expects to make five dollars per day; but that sum would only give him three dollars for his time—the same as his men get—and two dollars for his skill and the use of his capital. This is a case where the employer is possessed of ability to manage the ten men as laborers only, and for such a man five dollars per day for the necessary study, anxiety, and responsibility, can not be deemed out of proportion.

When the man of fifty looks at his boy associates and their careers, probably he will find that only one in ten has reached a handsome competence by his own exertions, and that one because he was energetic, faithful, competent, and thorough systematically from the start. If for a time he served under another, he was careful to do a little more than was expected of him, and did it well. This created confidence and desire on the part of his employer to see him prosper, and a disposition to assist him. In course of time his employer lends him capital, or makes him a partner in the business, and then his fortune is assured. Why

did not the other ten boys do the same? Obviously because there was but one chance in ten of that kind, and the one got it, so the others had to be content to serve in less profitable callings.

The regiment has but one colonel, the company but one captain, the State but one Governor; and any great business has limitations to the number of bosses it can find use for. There must be operatives as well as managers, and generally capacity finds its way to the front, and incapacity goes to the rear, as a matter of course, or according to the law of gravitation.

When one finds an opening, and leaves the operative class for the managing class, the value of his service shows for itself in some way that commands recognition. Thus, in the early days of agriculture, farmers send their produce to market by a man who makes a business of marketing for others. He can handle the product of ten farms, say, and hence twenty farmers give a living to two middle-men. After a time a man turns up that is smart enough to sell the product of twenty farms, and obtain better prices for the producers, by taking off a little from the commissions, and soon he gets all the business, and his two rivals are obliged to retire from the field. When they are out, the profits which were divided between two are taken by one, less the small discount that he made to the farmers to secure their custom. Now, doing the work of two, he saves the time and the expenses on the road of one, and so, while they just made a living, he rapidly accumulates, and makes money faster than the farmers who raise the produce which he only sells. In a few years he is the richest man in town, and the farmers, looking only at the result, are dissatisfied, and though he has done the selling for them for less than they could possibly have done it themselves, and also for less than any other man had ever done it for that community, they complain of him as an extortioner, or robber of the poor men who have done all the hard work. To state it mildly, he is a non-producer who has eaten up the farmers of the town.

And what has happened to the farmers has happened to all others. The competent manufacturer has come in, and by doing a much larger business has retired several incompetents to the ranks; the competent trader has done the same, the banker has done it, the expressman has done it, and all others have where there was a chance. From what has been said, it is apparent that the cost of living to the middle-men is not the prime factor in measuring the pay for their services. In the first case named, the farmers were satisfied with paying the larger commissions so long as the men earned only a living, they taking the living as the proper measure, and then they wanted to apply the same measure to the better man, and leave out of

the account his better service and management, and lower commissions. They were more content with two dawdlers and inefficients, than with one brisk, energetic, and go-ahead fellow, who served them in better fashion.

It is found, after a term of years, that the one efficient man has saved a handsome property, and has money to lend to others to increase business, and that somehow his portion of taxes and public burdens is very large, and a material help to town expenses, while it is certain that the two men he displaced do not lend any money or pay any taxes of consequence, and probably never would had they retained the business which he took from them. The inefficients would have allowed matters to run along in a careless fashion, and they would have consumed their commissions in living expenses, so that nothing would have been added to the general stock; but the new and vigorous man having come in, the community, instead of having two poor persons who can pay no taxes for highways and schools, has a capitalist who does pay, and who also has money to lend to men who need. The common people in these days decry the richest man in town, and think him a detriment, a sort of incubus or dead-weight which the people are compelled to carry, whose money has been made out of them by craft, and they imagine that had the laws of right and justice prevailed, their burden would not have existed. They do not for a moment dream that his capital would never have existed had the old dawdlers kept on to the end.

Nevertheless, they do believe in capacity, and they vote for the competent man for Governor, and town clerk, and assessor, and when they want a farm-hand or market-man they employ the best for the money, and only grumble after the service has been performed. They know that the best help is the cheapest all the time, save at the moment when they look at the aggregate reward in the lump. They know that a good hand is more profitable than two half hands, because the board of one can be saved. Now, the men who manufacture or engage in trade are the servants of the people as certainly as the Governor of the State or the county clerk. They combine materials and exchange goods for others simply because the others find it for their advantage to have them do it. I do not buy at the store because the merchant compels me, but because it is not profitable for me to keep store myself. By getting the manufacturer to take my wool and turn it into cloth I get more cloth. I create the manufacturer by asking him to help me to get the most cloth. In early times the shoemaker went from house to house with his lasts, leather, and patterns tied up in a sack and slung over his shoulder, and made and mended in the family kitchens. That kind of shoemaker

long ago disappeared, and is no longer here to be laughed at. He was succeeded by one who stayed at home and worked in his own kitchen. The other went out of business because he came in. He drove the other out, and out to stay; he will never return; he demonstrated to people that the old cobbler was not the best resource for foot-gear, and the moment this was made plain the old system went under; he saved time in packing and unpacking, in traveling to and fro, in waiting, and in many ways made it more convenient all round, so that it was cheaper for customers and better for the workman to have the new system.

Later on the kitchen workman had to abdicate in favor of a man with a shop, a grindstone, shelves, better light and heat, and numerous appliances impossible in a farmer's kitchen. When this man had held the fort a while, the regular manufacturer, with a large building for cutting, sorting, storing, and caring for goods, put in an appearance, and the man with the small shop and comfortable loafing quarters stepped out in the same way and for the same reason that his predecessors had. The new-comer could do better service for less money; the manufacturer came because the world knew what it wanted and sought him. The world wanted some one capable of stopping the enormous wastefulness of the old system. The newest man has made the old cobbler and his ways appear ridiculous, and the operative of to-day lives better than the well-to-do farmer of 1786. If the old way is the better, there is nothing in the way of returning to it, only the one fact that people can not afford to. Let him that thinks the old plan the better start out with his bundle of lasts and kit and try to earn a living in the good old way.

Attempts at co-operation thus far have generally shown a strong if not fatal tendency to failure because of the difficulty of commanding the requisite skill and faithfulness in management. Co-operators are not willing to pay the price for service which their business needs in order to succeed. They always stand on the theory that the men who conduct great enterprises get too much for doing the business and the operatives too little. In course of time, and usually not very long time, their scheme goes down. This is because in the nature of things no hired person on a salary of fixed amount will all the time keep his wits alive and study into the small hours of the night devising ways and means to make money for other people. They propose in their constitution to take from capital and skill a portion of the profit that has usually been accorded to them and give it to labor; but after thousands of experiments during forty or more years of good business in this country there is hardly a single case of such undoubted success as to warrant the assertion that demonstration of feasibility has been attained. The combined skill of all the co-

operators in half a century has produced no concern of magnitude. The almost uniform failures seem to prove that great management must have great compensation, and in endeavoring to get the skill without the pay the co-operators' dream has come to naught.

Now, this is equivalent to saying that the world finds its business can be done at less cost than by co-operation. The latter fails because it is undersold and unable to compete with such skill as gets the better pay.

Had Commodore Vanderbilt been content with the salary of a steamboat captain he would never have developed into a great business man and railroad manager. The prospect of great emolument brought into exercise great powers, so that he cheapened transportation in an astonishing degree and yet made money to an astonishing amount. The people who saved four or five dollars in a round trip between Boston and New York, and the people who got their barrel of flour twenty-five cents less because he ran a railway to Chicago, enjoyed the sensation at the time, but, when they saw his fortune, could not refrain from tears to think of the merciless robbery they suffered at his hands. It is the old story of the farmers and the market-men told at the beginning of this paper. The thing happened and succeeded, not because Vanderbilt was a robber, but by virtue of his giving better terms to people who had to travel and had to eat bread. His inducements were such that he got the business. Suppose he and some others of the same kind of enterprise had not come upon the stage, what would have been the result? Evidently the old ways of business would have continued. We should still be going to Buffalo on canal-boats and creeping along the streets of our cities in dilapidated omnibuses, still be doing our journeying in stage-coaches over dusty roads and tedious hills at a great sacrifice of time, money, comfort, and strength. The enterprise of the money-makers has profited everybody else by exciting production and accumulation. The money-makers have taken pay not out of labor, but out of the increased production and savings which their efforts have secured. Individuals have sometimes suffered. The omnibuses were killed when the horse-car came, and A. T. Stewart did the business of a hundred small shopmen; but the people at large saved time in getting where they were compelled to go in one case, and got what they wanted at less cost in the other. The street railroad makes ten times the money that the stages did, and the people save money and time. The people can do better by buying of Stewart, and therefore they buy. They enriched him to the tune of thirty millions, clean cash. This is a great fact; but it does not show great robbery. It may show the very opposite. The very class of persons who find fault with

Stewart for crushing out so many small dealers are the same parties that say the great curse of society is the number of middle-men it has to carry. If there were anything in this, then Stewart certainly operated in the right direction by getting rid of a portion of the incumbrance; and he got rid of it in the right way, for he allured the customers to his shop by giving better bargains. Something was saved to buyers when they patronized him. Each buyer carried away a little bonus when he left Stewart's store. Something better than a chromo was obtained. It was a cent a yard on cashmeres, perhaps, an eighth of a cent on calico, a shaving on tapes, and a trifle on a paper of pins—just enough to get so much of the trade of the small fellows that they must retire.

Of course it follows that, if he still made too much profit, then he ought to have sold cheaper yet, so as to have driven out another lot of traders. But when we say "ought" in such a case, we must have some rule of a practical nature by which to determine the matter. This we do not have. We know that this merchant sold goods at so little profit that he ruined hundreds of competitors, and compelled their retirement from the field. Shall we say that they ought to have sold any lower? How can we ask him to sell at a profit on which the average trader breaks and starves? Shall we say that he did so much business that he was able to do it for less? But that does not meet the point. That is only saying he should have done less, and not that he should have done it cheaper. Society had no claim on him in this regard, and would have made nothing had it tried to enforce any. Had society asked him to sell less, all the goods not sold by him must have been sold by others, and at as high or higher rates. So society would not have been relieved of its burden of parting with so much of its product as was represented in the commissions or profits taken by Stewart.

But there is another view of it that brings us to the same conclusion. Stewart was in business for about forty years, and for many years sold twenty millions of goods per year. Had he sold but fifteen millions per year at a profit of five per cent, and invested the profit with his usual sagacity, he would have been worth more than thirty millions at the end of his forty years. That he left but thirty millions proves that his profit was not over five per cent on the average. The margin for labor to gain from is, therefore, in the neighborhood of five per cent, because Stewart has proved that the ordinary man can not part with more than that and continue in business. In other words, business stops when the margin goes down much below that rate.

There are some lines of business in which the profit is at times more than five per cent, but in the long run the average can not

amount to more than that. Competition increases from year to year, and profits tend downward all the time; consequently, it takes more talent and energy to make fortunes now than it did a few years ago. It is not so easy for a laborer to become a boss as it formerly was; and as the chances for rising to bosshood grow less, the hatred of bosses increases. This is a symptom of discontent, and an evidence of the unreasonableness of the philosophy which is at the bottom of the schemes for relief. Capital must be paid, skill must be paid, and, if they are each paid but two per cent of the accruing profits, one per cent only remains for labor to get as its share, and this to the laborer whose wages are one dollar a day would amount to but three dollars a year. That is something, to be sure, but as a means of elevating the laboring classes is of no account.

THE SCIENTIFIC SOCIETIES OF ITALY.

By Dr. W. C. CARALL.

TO Italy, more than to any other country, belongs the Renaissance. The soil was particularly favorable. Upon the fall of the Byzantine Empire its rich treasures of Greek manuscripts found their way from Constantinople to western Europe. The fleets of Venice brought the greater part of them to Italy, where they found liberal purchasers. The Greek scholars, finding their vocation destroyed in Constantinople by the Turks, flocked to Italy to teach and translate. The awakening mind of Italy viewed with eager delight this new world in literature. The eternal freshness and beauty of Homer and Plato, and the marvelous knowledge of Nature displayed by Hippocrates and Aristotle, when read in these full transcriptions of their writings, came with the force of a revelation to those accustomed to garbled extracts, loaded down with scholastic commentaries and absurd elucidations. The study of the classics became a passion of the few, and then the fashion of the many. In every city and large town of Italy academies were formed for the critical study of the manuscripts.

George Eliot, in her historical romance Romola, furnishes us with a very interesting account of the proceedings of the Platonic Academy of Florence, then under the patronage of the Medici. Not only pure literature and philosophy but scientific inquiry gained an impetus from these societies. Under the direction of such men as Alberti, Da Vinci, Toscanelli, and Da Porta, Nature came to be questioned in the proper scientific spirit.

Hitherto the scholastics would have had Nature to conform with man and not man conform with Nature. To these teachers

thoughts only were real, and all attempts to gain the secrets of Nature were considered useless and contemptible. And, strange as it may seem, the authority appealed to in support of these views was Aristotle himself—not the Aristotle as he was known in Greece and as he has come to be known later, but the Aristotle as he appeared under a double Arabian and Latin disguise. His commentators had no hesitation in ascribing to him just the contrary to what he had advanced. He was to be made orthodox at any price.

All knowledge of Nature that was accidentally unearthed was made to bear a theological import. Even the philosopher's stone was made a theological agent. It was supposed to be able to free man from sin. The search for the stone was commended, since God had promised it to all good Christians, and that passage from Revelation, "To the conqueror I will give a white stone," was quoted in support of this view. Even zoölogy was obstructed with miracles and legends, as witness the wide-spread popularity for centuries throughout Europe of that curious book the Physiologus, or the Beastiary. Without a doubt this book contains a greater number of errors to the page than any other treatise on natural history ever published. It had its origin in the early Christian centuries, when the tendency was to interpret the Bible in an allegorical method, especially resorted to in the earlier commentaries on the account of creation in Genesis.

Among the most astonishing of the statements of this remarkable authority on natural history are the following: "The lion (footprints rubbed out with the tail; sleeps with eyes open, cubs receive life only three days after birth by their father's breath); the sun-lizard (restores its sight by looking at the sun); the pelican (recalls its young to life by its own blood); the eagle (renews its youth by sunlight and bathing in a fountain); the phœnix (revives from fire); the viper (born at the cost of both its parents' death); the serpent (sheds its skin; puts aside its venom before drinking; is afraid of man in a state of nudity; hides its head and abandons the rest of the body); the hedgehog (pricks grapes upon its quills); the panther (spotted skin; enmity to the dragon; sleeps for three days after meals; allures its prey by sweet odor); the sea-tortoise (mistaken by sailors for an island); the hyena (a hermaphrodite); the otter (enters the crocodile's mouth to kill it); the salamader (quenches fire); the tree called peridexion (protects pigeons from the serpent by its shadow); the fire-flints (of two sexes; combine to produce fire)."

It was not because there was nothing better than this book that it gained such a popularity, for there were the works of Pliny and those of Aristotle, though abridged and perverted from their original meaning by commentators. It was because the mind of

the middle ages was childish, and, like a child, desired not so much what was accurate as what appealed to the imagination and to the love of the marvelous.

But in the fifteenth and sixteenth centuries there was an awakening in Italy, and when these correct copies of the works of Aristotle, which Cuvier pronounced "fresh after so many copies and young after two thousand years," and those of other classic writers became accessible, they found eager students.

From his study of the ancient authors Columbus received knowledge of cosmography and geography, which materially assisted him to his discovery of the New World. Anatomy found diligent students; Italian anatomists attained European reputation; it was at the school of Fabricius de Aquapendente at Padua that Harvey acquired that knowledge which afterward made his name immortal. Even the pencil of Titian was not above illuminating the pages of the great anatomical work of Vesalius. Titian was not alone among the artists of this period who became enamored with the new sciences. The greatest of these was Leonardi da Vinci, the most universal genius, perhaps, who ever lived. His Last Supper is one of the chief masterpieces of the world; he distinguished himself in sculpture, architecture, poetry, and music; he performed clever feats in engineering; anatomy, botany, geology, mathematics, astronomy, chemistry, and geography all received valuable contributions from his investigations. He anticipated many of those wonderful discoveries in physical sciences which fell to the succeeding generation to fully develop.

No better illustration of Da Vinci's acuteness of reasoning could be obtained, perhaps, than by quoting his observations on the origin of fossils. It must be remembered that geology did not become a science or the origin of fossils fully settled until two and a half centuries after this remark was made. He strenuously asserts the contents of the rocks to be real shells, and maintains the reality of the changes of the domain of land and sea, which these spoils of the ocean supply.

"You will tell me," he says, "that Nature and the influence of the stars have formed these shelly forms in the mountains; then show me a place in the mountains where the stars at the present day make shelly forms of different ages, and of different species in the same place. And how, with that, will you explain the gravel which is hardened in stages at different heights in the mountains?" Had Leonardo labored assiduously in art alone, there never would have been the need of Michelangelo and Raphael; had he confined himself strictly to one science, Galileo and Torricelli would have found their occupation gone. That which proved Leonardo's personal loss was Italy's gain, for his fertile

mind started trains of thought which lesser men could prosecute but could not have originated.

The Academy of Milan, instituted in 1485 for the study of the arts and sciences, of which he was director, had a far-reaching effect upon the youth of Italy of that day.

Later on Bruno and Da Porta arose to carry on a similar work for southern Italy. Bruno early espoused the Copernican system, and by the brilliant and fearless manner of his teaching did much to popularize this condemned doctrine.

Bruno was a philosopher rather than an experimenter, and his influence upon the science of the times was not so much what he himself contributed as what he inspired others to do after him. Yet in his work, *Del Infinito Universo e Mundi*, he makes an advance upon the Copernican system in declaring his belief in innumerable worlds besides that on which we live, and also that each star is a sun, about which revolve planets like our earth. In no country at this date was science being approached from so many sides or by such an array of minds as in Italy during the sixteenth century. With such a beginning the Renaissance ought to have done for Italy in science what it did for her in art, music, and architecture—made her the master and teacher of all Europe. But there was a repressive power in Italy, which chilled and stunted every shooting tendril which science put forth, and only when transplanted in France and England attained those fair proportions natural to its growth.

Art and architecture could be appropriated to the service of the Church, and flourished under the favor of the authorities; but the sciences as they grew became iconoclastic, and threatened the existence of some of the most cherished doctrines of the Church. It was decreed in Rome that all such dangerous questionings should cease, or else, as the shrewd politicians there foresaw, the authority of the Church over men's minds and thoughts would be soon overturned.

Adverse indeed were the times for the organization of a scientific society; yet the generous and enthusiastic Frederico Cesi undertook this very thing, in establishing the Accademia dei Lincei, within three years of Bruno's execution, and in Rome at that.

The story of this unfortunate young nobleman's unselfish yet misjudged labors is one of the most pathetic in the history of science. The Accademia dei Lincei antedates the Royal Society by sixty years, and the French Academy of Sciences by even more; yet, though at times its torch burned fitfully, this venerable body still exists and fills a place of honor and influence in its country similar to that occupied by the Royal Society and the

French Institute in theirs. Considering the adverse spirit surrounding it throughout the two centuries and a half of its existence, one can not but wonder that it ever survived or ever was revived.

Frederico Cesi, son of the Duke of Acqua Sparta, was but eighteen years of age when he founded the Academy in 1603, having been born in 1585, nor had either of his three associates passed the age of twenty-three. Young as was Frederico, he already enjoyed the acquaintance, personally or by correspondence, of the foremost scientists and philosophers of his time. His first associate in his undertaking was Francesco Stelluti, who appears to have been prompted by an ardor for study and a nobility of character similar to that of Frederico. The third of this little band was Heck, Eckius, or Reckius, as he was variously called, a Hollander and a Catholic, who found the Calvinistic inhabitants uncongenial, left the Low Countries and settled in the town of Scandriglia, in Sabina, where he practiced medicine. His fame as a profound student in all the branches of philosophy reached the ears of Cesi, who invited him to Rome as an *attaché* to his family. A fourth member was added in the person of Anastasio de Filiis, a relative of the Cesi family, residing with them, and who was devoted to mechanics.

In order to give method to their studies these young men organized an Academy upon the 17th of August, 1603, which date was to be annually remembered by a day of festivity, and gave it the title of *dei Lincei* or *the Lynx*, from the well-known acuteness of vision of this animal, and with the motto, "*Sagacitas ista.*" The plans were drawn upon an ambitious scale. With the orders of the Church and the Masonic fraternity in their mind, they conceived of the organization of a world-wide society, embracing at the same time investigations of a scientific character with a broad philosophical brotherhood connected by affiliated lodges.

The meetings were to be private, and the members were required to be "philosophers eager for real knowledge, who will give themselves to the study of Nature, and especially to mathematics."

They met three times a week and had five lectures at each meeting, each one performing his own duty. Heck was reader in Platonic and Transcendental Philosophy. In one of his theses he proposed a medicine of his own to "keep the soul alert" and to prevent it from growing sluggish by reason of the heaviness of the body. Unfortunately, he could not have taken his own medicine, if it possessed the virtues claimed, neither does he inform us of what his medicine consisted. So we can never know whether Brown-Séquard's mixture had a prior discoverer or not. Each worked industriously, and besides their literary

labors they had, within two months of their foundation, constructed a great planisphere upon which they drew both the ancient and modern systems of astronomy.

But evil days came. Investigations, questionings, or any sort of freedom of thought was never looked upon with favor by the ecclesiastical authorities of Rome. Columbus had appeared before the great Council of Salamanca to have his claims of the sphericity of the earth and the existence of an attainable antipodes pronounced by the dignitaries "contrary to Scripture and absurd in philosophy"; but he, with a persistence inconsistent with a good Catholic, at last sailed across the waters and discovered what his judges declared did not exist.

Copernicus had written and submitted to Pope Paul III a system of astronomy which was also pronounced contrary to Scripture and erroneous in philosophy, and the books were condemned and publicly burned.

Bruno had just been silenced by fire for upholding this Copernican system and other heresies; Porta was soon to appear before Pope Paul III for trial and to be warned against resorting to the black arts, because of his scientific attainments; and Galileo was to undergo more shameful treatment for "thinking different to what the Dominicans allowed." So, when Cesi and his friends began their investigations of Nature, studies which had hitherto brought nothing but disturbance, unrest, and revolt at the authorized doctrines, it is not surprising that efforts were made to stop them.

The young men were asked if they had not the works of Aristotle and of Thomas Aquinas, both accepted authorities by the Church for centuries; and if so, why not be content with them, for surely they did not imagine they were greater than these masters in science? But these tactics did not avail. Then appeal was made to Cesi's parents. The old duke was a man of domineering disposition and violent passions, and was unscrupulous of means in gaining his end.

He was told his son's morals were being undermined by his associates, and sought to alienate him from them, but without success.

Attempts were made to reach him through his mother, by arousing her fears as to his morals; but she, with a mother's instinct, could not be poisoned against him.

The duke threatened dissolution of the Academy by force. On Christmas-day young Cesi called his friends together, and, in order to remove all suspicions against immorality, recast their constitution and laws, by which it was ordered that all future meetings should be opened by reading one of the Psalms of David and by prayer. According to the custom of the times, the Academy was

put under the patronage of one of the saints—St. John, the "apostle of hidden visions," being chosen, to whose church they repaired in order to gain his assistance in their troubles. But all this only increased the duke's resentment, and young Cesi saved himself from his father's wrath by flight, while Stelluti and De Filiis were sent home under guard.

Though separated, they found means of correspondence. Eckius did not escape so easily. It appears that while in Holland he was compelled to take a man's life in order to save his own, but so clearly in the right that he was not even put upon trial.

The duke, with dark treachery, through pretended friendship, secured from Eckius the names of all the witnesses and his personal enemies, then hurried them to Rome to appear against him before the ecclesiastical authorities. His rooms were ransacked for any damaging evidence against him; and his instruments and manuscripts destroyed.

After lying concealed until almost starved he surrendered, when he was turned over to a troop of soldiers to be returned to Holland.

But, though footsore and weary from the forced marches, the scientific spirit was still alert and uppermost. His observations of natural history, written during this unhappy journey, he sent, together with the drawings illustrating them, to Rome, where they, with other valuable manuscripts of the Academy, were kept treasured in the Albani Library until the French invasion.

The year 1609 was a memorable one in the annals of the Academy, as it was of science in general, as the date of the invention of the telescope. When, in the spring of this year, a rumor of the accidental discovery at Middelburg of the magnifying power of certain lenses, which suggested to the alert mind of Galileo the telescope, reached Italy, Della Porta, in a letter dated August 28th, from Naples to Cesi, gives a drawing of a telescope with a reference for its principles to his work on Optics, published in 1589. Since Porta did not see the telescope until Galileo brought his to Rome in 1611, the Neapolitan, by his own great knowledge of optics, conceived of the correct principle on which it must be built, and thus far forestalls Galileo; but—and the but is here all-important—Porta simply made a sketch, while Galileo *built* the instrument. The records of the Academy of this date determine that the words "telescope" and "microscope" were first used by Frederico Cesi. "In 1609 the Government of Venice made a considerable present to Signor Galileo, of Florence, Professor of Mathematics at Padua, and increased his annual stipend by one hundred crowns, because, with diligent study, he found out a rule and measure by which it is possible to see places thirty miles dis-

tant as if they were near, and, on the other hand, near objects to appear much larger than they are before our eyes."

In 1610 Porta became a member of the Academy. The first academy for scientific investigation to be established in modern times was the Accademia Secretorum Naturæ, which he founded at Naples in 1560. Porta was the President and leading spirit of this Academy until it was interdicted by the Pope, and Porta compelled to go to Rome to defend himself against the charge of magic and black arts. Porta became Vice-President of the Lincei, and some of his greatest works were published under its auspices, among which were *Magiæ Naturalis; De Humana Physiognomonia,* from which Lavater is said to have borrowed so extensively; *Phytognomonica,* a treatise on the physiology and virtue of plants; *De Refractione, optices parte,* in which he speaks of binocular vision; on *Pneumatica,* and various other works. In the *Magiæ Naturalis* he describes the camera obscura, which he had discovered, and mentions the many optical experiments he had made with it. He considered the eye a camera obscura, and thus approximated the true idea of vision. Here we find the passage, written several years before, in which he speaks of a combination of lenses by which "we may contrive to recognize our friends at a distance of several miles, and those of weak sight may read the most minute letters from a distance. It is an invention of great utility, and grounded on optical principles, nor is it to be understood by the vulgar, and yet be clear to the sharp-sighted." Who knows what Porta would not have done, with these facts in his possession, had he not been deterred by the charge of resorting to black arts, already resting upon him! Why should he, he may have reasoned, put to practical test that which, in his then present position, would almost certainly lead him to the stake. Galileo was a bolder man, and enjoyed the patronage of the powerful Medici, yet even he paid the penalty of his boldness.

When Galileo brought his little telescope to Rome in 1611, and set it up in the Vatican gardens, very naturally his most enthusiastic supporters were the Lynceans. Early in the year he became a member of the Academy. His signature runs as follows: "Ego Galileus Galilæus Vincentii filius Florentinna ætatis meæ anno LII, Sal. 1611 die 23 April: Romæ manu propria scripsi." The whole of this, the first visit of Galileo to Rome, was one continued ovation, being received with the most marked distinction by the ecclesiastics and scientists alike. The experience of one looking through a telescope for the first time, at the moon, for instance, must have been novel indeed.

Those of us who remember the sensations they experienced when witnessing for the first time the workings of the telephone or phonograph can make only an imperfect comparison; for we,

unlike Italy in 1611, live in a day when mechanical wonders are becoming commonplace. The whole relation of the Academy with Galileo is full of interest. The Transactions of the Academy give accounts of the members studying the heavens through Galileo's telescope. Cesi makes haste to write to his friend Stelluti in April, 1611, of what he had observed. The moon he finds to be "mountainous, cavernous, sinuous, abounding in water," and the heavens are "either in a state of flux and not different from our own air, or else are such as the Pythagoreans held them to be." What a contrast to these days of revelation was Galileo's second reception in Rome four years later! In his work on the solar spots he was led to espouse the Copernican system. This was a heresy already tabooed. All the old warm friendships and smiling faces became suddenly cold. Galileo still hoped to placate the authorities, and demanded a test by experiment to prove the correctness of his hypothesis; but this was the last thing his enemies would have allowed.

They remembered his challenge to the Aristotelians to test their and his views on the laws of falling bodies from the leaning tower of Pisa, and its result.

The only pleasant feature about this whole unhappy affair is the almost unanimous support and sympathy given by the members of the Lincei. And this meant not a little sacrifice on the part of the Academy, considering the condition of affairs at this time.

Throughout the long controversy with the Church, Galileo received nothing but encouragement and assistance from the Academy.

Some of his greatest works were printed at the expense of the Academy; and when one of its own members became Galileo's accuser, the Academy censured and practically expelled him from the body. Not the least among the splendid achievements of the Academy was the publication of the observations of Hernandez upon the natural history of New Spain (Mexico).

This celebrated naturalist was sent by Philip II to New Spain. The result of several years' faithful labor was embodied in a voluminous work, with numerous illustrations, describing the natural objects of the country with such fidelity and thoroughness that, in spite of the researches of more recent naturalists, it still enjoys the highest reputation. The expense attending the collection of material, drawings, and specimens for this great work is said to have amounted to sixty thousand ducats. Yet for fifty years this manuscript was neglected, no serious effort having been made to publish it. Then the indefatigable Cesi discovered it, had three of his colleagues of the Academy—Terentio, Fabro, and Colonna—to edit and annotate it, when the work was pub-

lished at the expense of the Academy, several years later. It is curious to find prefaced to this edition a brief, dated 1627, of Pope Urban VIII, in praise of the Academy.

Cesi dedicated his work on his microscopic studies of the bee to the same Pope.

When we remember that this was the Pope under whom Galileo was condemned, we learn to what extent the casuistry of the day carried men, when it allowed the Pope to praise science yet condemn the results of science, and to lead the Linceans, as indeed Galileo himself, to insist that the Copernican system was not necessarily true in fact, but true *ex hypothesi*.

So long as Cesi could remain at the head of the Academy it continued to flourish, but began to suffer and decline after he was obliged to remove from Rome to his estates, about a hundred miles from the capital.

The old duke, by his reckless and extravagant mode of life, had so involved the estates that they became unremunerative. So, with characteristic selfishness, after reserving for himself an annuity, he turned over the estates to his son, who assumed all debts.

Cesi bravely struggled to meet these extra responsibilities and cares, and bore with uncomplaining patience the increased petulance and tyranny of his father, but his slender frame was unequal to the task, and in a few weeks after his father's death he was laid beside him in the grave, having died on the 2d of August, 1630, in his forty-fifth year.

A charming, learned, noble-minded man, he died too soon for science, a victim of filial duty. What Cesi had done for others he failed to have done for himself, for the result of his own labors, *Theatrum Naturæ*, was never published, but remains in manuscript, in the Albani Library at Rome, to this day. Cesi was one of the earliest to make accurate observations on fossil woods, and to discover the system of propagation of ferns.

The Academy struggled on for twenty years after Cesi's death, and finally lapsed, to be revived again in 1784, since which time it has forced itself into the fore-front of the scientific bodies of Europe.

The unfortunate circumstance attending the lapse of the Accademia dei Lincei was the lack of unity of the states of Italy, each state or republic having its own academy, thus precluding a strong central representative body, such as the Royal Society of London, the Institute of France, the Academy of Sciences at Berlin, and the Academy of Sciences at St. Petersburg, stood in relation to their own kingdom. The Accademia del Cimento at Florence, and the Academies at Bologna, Turin, Milan, Naples, all flourished at different times under the presidency of some great

leader in science, as Viviani, the great geometer, and Torricelli, the inventor of the barometor, at Florence, the Morgagni at Bologna, and Da Vinci at Milan.

If all these could have been consolidated into one central corporation, their Transactions would have compared favorably with those of any other similar society. Another source of the unfruitfulness of Italian scientific societies was the emigration of some of their most eminent members to foreign cities, induced by the wider fields and richer rewards which such cities as Paris and St. Petersburg offered in contrast to those of one of their narrow republics.

But more than all this, more than all else combined, was the deadening influence of ecclesiastical disapprobation. In this atmosphere no freedom of thought or independence of research was possible.

To what purpose were life and energies to be devoted to the discovery of some great law of Nature, to find the results, if displeasing to the ecclesiastical authorities, interdicted from publication, and the person, instead of decorations, subjected to imprisonment, or worse? But the present and future are more hopeful. The atmosphere is clearer and healthier, although it required the thunder and lightning of Garibaldi and Victor Emanuel to effect it.

The old Italy has passed away.

There is now a *Giovine Italia*, and there is every indication of a new impetus to scientific research.

When we recall such names as Columbus, Cardan, Leonardo da Vinci, Bruno, Galileo, Porta, Cesi, Fabricius, Torricelli, Viviani, Telesio, Campanella, Vanini, Bovelli, Cassini, Bellini, Morgagni, Malpighi, Galvani, and Volta, it is but to be reminded of many of the most glorious achievements of science, though some of the authors were obliged to go to other countries to obtain them, while of those who remained in Italy some were rewarded with the stake. If so much was done under such adverse circumstances, one can not but wonder what would have been the result had science received the same encouragement in Italy that fostered art and music, and which science received in London, Paris, Berlin, and St. Petersburg.

THE present position of anthropology, says Dr. Alexander Macalister, of the Anthropological Section of the British Association, is critical and peculiar; for while on the one hand the facilities for research are daily growing greater in some directions, the material is diminishing in quantity and accessibility—treasures both of the structure and the works of man are accumulating in our museums, but, at the same time, some of the most interesting tribes have vanished, and others are rapidly disappearing or being absorbed in other races.

SKETCH OF HENRY WALTER BATES.

HENRY WALTER BATES is best known to science as the propounder of the doctrine of protective resemblance or mimicry; and to science and the reading public as the author of the book, A Naturalist on the Amazons, which has been accorded by competent critics a place as a scientific book of travels alongside of Darwin's Voyage of a Naturalist, Wallace's Malay Archipelago, and the volume of Hooker.

Mr. Bates was born in Leicester, England, February 8, 1825, and died in London, February 16, 1892. He was the son of a manufacturer of his native town, known as "Honest Harry Bates," and was intended for a business career. After receiving the usual instruction of tradesmen's sons at a boarding school in Billesdon, he was apprenticed to Alderman Gregory, hosiery manufacturer, Leicester, in whose shop his working hours were from 7 A. M. to 8 P. M. With all the laborious character of his duties, it was during the apprenticeship, his brother says, that he laid the foundation of all that he afterward was. He became a member of the Mechanics' Institute of Leicester, which had a good library and numerous evening classes with competent masters; entered the Greek, Latin, French, drawing, and composition classes; "and worked with an energy and perseverance that brought him to the front in all." This he did by studying late into the night and in the early hours of the morning. He was a diligent reader, setting special value upon Gibbon's great history, joined a glee club, learned to play the guitar, and became known as a good barytone singer.

While attending the classes in the Mechanics' Institute he became acquainted with a number of gentlemen who had tastes for natural history. He was specially inclined to entomology, and cultivated first the *Lepidoptera* and afterward the *Coleoptera*. Holidays came rarely to the boy, but they were eagerly utilized for collecting excursions, beginning the year's work usually with Good Friday. Young Bates habitually wrote descriptive accounts of his expeditions, and was accustomed to sketch and write out descriptions of all the principal insects captured.

After the death of Alderman Gregory, his master, several years before the expiration of his apprenticeship, Bates managed the business on a small scale for the deceased proprietor's son. He had formed an extensive collection of British beetles and was in correspondence with the chief coleopterists of the time. Probably his first contribution to entomological literature was a Note on Coleopterous Insects frequenting Damp Places, which was published in the first number of The Zoölogist, in 1843. A situa-

tion was procured for him in the offices of Messrs. Alsopp, Burton-on-Trent, where he remained, in an uncongenial atmosphere, till arrangements were made for his starting with Mr. Alfred Russel Wallace on their scientific expedition to the Amazons.

He first became acquainted with Mr. Wallace in 1844, when Wallace was a master in the English Collegiate School, and began a correspondence with him. Three years later, or in 1847, Mr. Wallace suggested a joint expedition to the Amazons for the purpose of exploring the natural history of its banks, and of gathering facts, as he said, "toward solving the origin of species." The two friends, after spending some time in studying South American plants and animals in the principal collections in London, embarked in a small trading vessel April 26, 1848, and arrived at Pará May 28th. They set to work forthwith, sending home from time to time duplicates of their collections to defray expenses. Though zoölogy was the primary object of their expedition, they also acquired much geographical and ethnographical information. Pará continued to be the headquarters of the two, and of Bates after the separation, from which their excursions were made and to which they returned, and after the departure of Wallace, till November 6, 1851, when Bates started on his voyage of seven years and a half to the Tapajos and the upper Amazons. One of their excursions was down the Tocantins River and to the town of Cametá, and furnished much information on the subject of the complicated river geography. In September, 1849, Bates started on his first voyage up the Amazons in a small sailing vessel (for steamers were not established until the year 1853) and reached Santarem, which he subsequently made his headquarters for a period of three years, but on this journey he pushed on to Obydos, about fifty miles farther. Here a trader was found who was proceeding in a *cubesta* laden with merchandise to the Rio Negro, which was arranged to stop frequently on the way, and Bates, securing a passage, once more increased his knowledge of the Amazons. The destination of the boat was Manaos, or the Barra of the Rio Negro, a spot rendered memorable by the visit of Spix and Martius in 1820. After a short stay Bates proceeded to Ega, the first town of any importance on the Solimoens River, which he reached on the 26th of March, 1850. Here he spent nearly two months before returning to Pará, and thus finished what may be considered as his preliminary survey of the vast collecting ground to be almost called his own. In November, 1851, he again arrived at Santarem, on a second journey, where, after a residence of six months, he commenced arrangements for an excursion up the little-known Tapajos River, which in magnitude stands sixth among the tributaries of the Amazons. A stay was made at the small settlement of Aveyros, and from this spot

an expedition was made up the Cupari, a branch river which enters the Tapajos about eight miles above it. At this time Bates was thrown in contact with the Mundurucus Indians, and was able to acquire much valuable ethnological information. It was also during this second journey that the long stay was made at Ega, and the many excursions in its neighborhood resulted in so much general knowledge, both zoölogical and geographical. Bates returned again to Pará on the 17th of March, 1859, after an interval of seven and a half years in the interior. During this long sojourn in the tropics Mr. Bates obtained more than 14,700 species of animals, of which 14,000 were insects, and of these 8,000 were new to science.

After they had been two years together in South America, Mr. Wallace separated from Bates, to visit the Rio Negro and the upper waters of the Orinoco, whence he subsequently went to the Malay Archipelago.

Mr. Bates sent contributions to The Zoölogist from time to time during the whole of the eleven years which he spent in the Amazonian regions. One of his letters gives a curious picture of him as equipped for a day's expedition, in colored shirt, trousers, boots, and old hat; his double-barreled gun over his shoulder, loaded with two kinds of shot; his net in his right hand, while "on my left side is suspended a leathern bag with two pouches, one for my insect-box, the other for powder and two sorts of shot; on my right side hangs my 'game-bag,' an ornamental affair, with red leather trappings and things to hang lizards, snakes, frogs, or large birds; one small pocket in this bag contains my caps, another papers for wrapping up the delicate birds; others for wads, cotton, box of powdered plaister, and a box with damped cork for the micro-lepidoptera; to my shirt is pinned my pincushion, with six sizes of pins."

The summary of the adventures and results of his voyage is given in the Naturalist on the Amazons, "one of the most delightful books of travel ever perused, full of varied information charmingly arrayed," which, prepared after the persistent urgency of Darwin, was published in 1863. This was Mr. Bates's only book.

His most memorable contribution to biological science was a paper published in the Transactions of the Linnæan Society, entitled Contributions to an Insect Fauna of the Amazon Valley, in which the phenomenon of mimicry was unfolded and explained as a means of protecting animals—by giving them guises tending to ward off pursuit by enemies, or by so likening them to surrounding objects that they escape notice. Darwin spoke of the book as one of the most remarkable that he ever read, and "as clearly stating and solving a wonderful problem," and found in it a strong support of his theory of natural selection.

In a paper on the classification of the *Rhopalocera*, or butterflies, Mr. Bates proposed a new system of arrangement by which the progressive modification in structure, or the evolution from a simple to a more specialized type, could be shown. Its merit is attested by the fact of its almost universal adoption in later works on evolution and natural history.

Mr. Bates's long sojourn in the region of the Amazons, fruitful as it was in scientific results, was detrimental to his constitution, and he returned "a wreck of his former self." His "frame remained enduring, but the elasticity had been taken out of it." But "we may rest assured," says the Proceedings of the Royal Geographical Society, "that nothing but physical prostration actually brought about the long-deferred return to England, and this abandonment of the anticipated visit westward, 'to gather the yet unseen treasures of the marvelous countries lying between Tabatinga and the slopes of the Andes.'"

In 1864 Mr. Bates was appointed Assistant Secretary of the Royal Geographical Society, a position in which, says The Athenæum, for the last twenty-seven years he exercised an influence "none the less effectual that he always carefully avoided any action that might make it or himself conspicuous over the progress in our country [England] of geographical science. He had the satisfaction, while other sciences have more or less specialized themselves, of seeing Geography throwing aside the restrictions that bound her to mere records of discovery and surveying, and taking her true place as a link between the other natural sciences, viewing them all from her own separate standpoint, and bringing out the points of connection between them, from a special and novel aspect." He edited the Transactions of the society from the beginning. In this office, according to Mr. Clements R. Markham, "he was unwearied and most successful in obtaining information bearing on geographical work from every quarter and in all parts of the world. He supplied invaluable hints and suggestions to the authors of papers, and he smoothed over difficulties with never-failing tact. His own rich stores of information were invaluable to all who needed help in their work, and over and over again they enabled him to supply a missing clew in some difficult inquiry, or to elucidate and piece together isolated facts, and show their bearings on each other. In all their intercourse with him, his colleagues, as well as the general body of geographers and travelers, have always been as much impressed by his ability and knowledge, and by the soundness of his judgment, as by that simple and kind-hearted way of giving advice which endeared the late assistant secretary to all who came in contact with him."

Among the notices of Mr. Bates's personal characteristics con-

tributed by his old friends to the Transactions, Sir Joseph D. Hooker tells of the time when he first saw him, at Mr. Darwin's, at Down, shortly after his return from the Amazons. "We there spent several days together, and I can remember none more enjoyable. There was such a fascination in his manner and character, and such a boyish, hearty enjoyment of his return to his native country, and all that it contained, from Shakespeare to Punch, and from Darwin to the merest bug-hunter (so long as the work was honest). Darwin's appreciation of him was wholehearted and all-round, and Bates's first visit to Down was marked with a white stone in his host's memory, as in mine, and often recurred to by us." "Perhaps, to know him at his best," says Mr. Edward Clodd, "and pierce the thick husk of his modesty, was when, the evening employment of beetle-sticking over, and the frugal supper eaten, the pipe was lit and talk started, sometimes on some topic of the day, but, more often, on some subject suggested by his wide and varied reading." Says a writer in The Academy, whose initials indicate that he is also Mr. Clodd: "His leisure hours, diversified by chat with one or two intimates and by omnivorous reading, were mainly devoted to the classification of certain families of the *Coleoptera*, his collection of which, although partly in course of dispersal, is unique. . . . The results of this labor of love and of years are entombed in technical memoirs, and notably in the scarcely more accessible *Biologia Centrali Americana*." Hooker was impressed with his "power of mind," and with that, says this writer, "was conjoined the simplicity and teachableness of a child."

Mr. Bates received many honors, but he never spoke of them, and no one knows how many or what they were. He was made a Fellow of the Linnæan Society in 1871, and of the Royal Society in 1881, and he was twice President of the Entomological Society.

According to Dr. J. J. M. de Groot, of the University of Leyden, whose paper is illustrated by specimens from his collection, the wedding garments of a Chinese woman are symbolical of the happiness, official dignity, and long life which she desires for the numerous children expected to bless the union. These hopes are represented by the dragon, the bat, the stag, the tortoise, and the crane or stork. The head-gear is very elaborate, and is attached by a silver hair-pin with a head of precious stones. These gorgeous garments are frequently used as grave-clothing for the mother, by the piety of the sons, who believe that to place things of good omen in the tombs of ancestors is to secure for themselves and their offspring the blessings of which they are emblems.

Asteroid No. 323, the first that was discovered by the aid of photography (by M. Wolf, of Heidelberg, November 28, 1891), has been named Brucia, after Miss C. W. Bruce, of this country, who has appropriated a considerable part of her fortune to the aid of astronomical research.

CORRESPONDENCE.

THE ABANDONMENT OF PENIKESE.

Editor Popular Science Monthly:

SIR: On my return after a protracted absence, my attention was called to an article by President D. S. Jordan on Penikese in the April number of The Popular Science Monthly. Mr. Jordan is mistaken * as to the causes which brought about the close of the Anderson School at Penikese. If he had taken the trouble to look up the history of the relations of the second director of the school with Mr. Anderson's representatives, he would have found a very simple solution of the matter.

The fund given to Prof. Agassiz by Mr. Anderson was spent in the equipment of the school and in paying for its running expenses during the first year. At the end of the first year it became apparent to all concerned that Penikese was not a locality suited for a marine laboratory. This had been anticipated by some of Prof. Agassiz's friends, who urged him not to accept the gift of the island of Penikese as a permanent home for a summer school.

The second year was carried on by the trustees in the hope of obtaining from Mr. Anderson the permission to remove the school to Wood's Hole, and with the further understanding with Mr. Anderson's representative that Mr. Anderson would be responsible for the expenses of the school during its second term. Neither of these expectations were realized, and one of the trustees was compelled to meet the expenditures, which amounted to a large sum, and are still a charge upon the school. The attendance during the second year was larger than during the first year, and the applications for the third year were beyond the capacity of the school to meet. The second director did not feel inclined to carry on the school at a locality which he had condemned as unfit for the work, and which was handicapped by its isolated position, involving, in addition to the expenses of a favorable locality, extraordinary expenditures in the way of transportation amounting to more than the ordinary expenses of the school. Nor did the second director feel called upon to meet this wasteful expenditure for the sake of carrying on an enterprise which ought not to have been located where it was, and could not be carried on successfully as long as it remained in its original site.

Having thus failed to obtain Mr. Anderson's consent to the removal of the buildings to Wood's Hole, and finding, in response to an appeal from the trustees, that no educational institution in the country cared sufficiently for the scheme to co-operate with them, the trustees represented the case to the Legislature of Massachusetts, and were authorized to convey all right and title to the island, and to the buildings erected upon it for the use of the school, back to Mr. Anderson.

ALEXANDER AGASSIZ.

CAMBRIDGE, MASS., *September* 4, 1892.

* The yacht given to the school was presented by Mr. C. W. Galloupe, and not by Mr. Anderson, as is stated in the article quoted above. Mr. Galloupe generously allowed its sale, to meet a part of the debts of the school.

HOLE OR HOLL?

Editor Popular Science Monthly:

SIR: A letter from Mr. Joseph Story Fay, addressed to "Prof. Edward F. Fernald, Centre College, Pa.," was received by Prof. H. T. Fernald, State College, Centre County, Pa., and by him was sent to me—for whom its remarkably accurate writer intended it. In his letter Mr. Fay takes exception to the allusion to "Wood's Holl," in my article on Changes in Chemical and Geographical Words in the September Monthly, as "the meaningless corruption of Wood's Hole effected by finical summer visitors." As to who effected the change, my authority was the United States Board on Geographic Names, which says in its first report (1891), "The name, which was originally Wood's Hole, was changed several years ago by the summer residents of the place to Wood's Holl." But Mr. Fay says there were no summer visitors there when the change was made, and, as he has lived in the town over forty years, doubtless he knows.

Mr. Fay also incloses a pamphlet giving the theory on which the change was based, but I regret to say that it consists mainly of "may be's" and "why not's." On this point the Century Dictionary has the following, under *hole:*

"In 1875 the name *Wood's Hole* was changed to *Wood's Holl*, in conformity with the (unfounded) supposition that *hole* in such local names is a corruption of a Norse word *holl*, meaning 'hill,' introduced by the Norsemen in the tenth century, and preserved from that remote period by the American Indians."

This quotation follows the above: "This [flag] was to be raised at a good anchoring-place called Five-Fathom *Hole*."—*Ellis, Voyage to Hudson's Bay* (1748), p. 149.

The village of Woods Holl takes its name from the adjacent strait. Any one who remembers the "swimming-hole" of his boyhood will see no need of explaining the word hole as applied to a body of water by means of the Norwegian word for the neighboring hill.

Very truly yours,

FREDERIK A. FERNALD.

NEW YORK, *September* 20, 1892.

EDITOR'S TABLE.

EVOLUTION IN POLITICS.

IN an address on The Impending Political Epoch, delivered last fall before the Ohio Society of New York, the Hon. John M. Ashley pointed out some features in the structure and workings of the Government of the United States which recent developments have shown to be full of peril to the integrity and security of our institutions. They may be described in a group by the phrase, "Unequal distribution of political power." The habit of regarding the Constitution of the United States as a perfect instrument, testifying to extraordinary wisdom and foresight on the part of its framers, ceased many years ago. The trials of the war and reconstruction disclosed many weak and some mischievous features in it, the existence of which was confessed, while they were hardly remedied, in the amendments. The course of events has disclosed other features which may also, in a more or less distant future, prove equally mischievous with those which we have tried to remedy. The most obvious of these is the roundabout system of electing a President by Electoral Colleges chosen by the voters of the several States. The framers of the Constitution are supposed to have intended to provide for the election as President of the man whom the body of electors, carefully chosen for their wisdom and experience as well as for their integrity, should decide to be most fit for the office. The plan has had no such effect, but has simply stood as an obstacle to the free exercise of their choice by the people. There is more positive mischief concealed in it, for, while the electors now respect the choice of the people, so far as it is shown in the nominating conventions, the case might arise in which they should combine to substitute for the ostensible candidate some man who had never been thought of, and who would be rejected by the people at once if he were proposed to them. Another danger is seen by Mr. Ashley in the provision that leaves the determination of the manner of choosing the electors to the Legislatures of the States, and thereby to the caprice of the party which may happen to be temporarily in the majority in the Legislature. A minority securing control for a single year may thus disfranchise or greatly weaken the influence of the majority of the voters of the State at the ensuing Presidential election—as the Republicans charge that the Democrats have attempted to do in Michigan, and as has been recently demonstrated by the action of the Republicans in Connecticut. The events that gave rise to the Electoral Commission in 1876 tell us of a danger growing out of the electoral college plan that we have already had to meet.

Possibilities of great mischief working in the electoral colleges and in the Senate are concealed in the powers possessed under the Constitution by States whose population is small and not likely to grow. Each State is entitled to two senators, and, according to the Constitution, it can not be deprived without its consent of its equal representation in the Senate. Under this provision, Nevada, whose population is not one third that of a normal congressional district, and is declining, is the peer in senatorial power of New York or any of the larger States; and there are now seventeen States in the Union whose combined population is that of the State of New York; but they have thirty-four senators to New York's two. Six new States, whose combined population is not more than enough to make one common-

wealth, three of which will probably never have a population sufficient to entitle them to more than one representative, were admitted into the Union by the last Congress—for partisan reasons.

It is provided in the Constitution that if the electoral colleges fail to choose a President, the election shall be made by the House of Representatives, when each State, large or small, shall be entitled to cast one vote. Mr. Ashley shows in a table that under the present apportionment the House of Representatives being composed of three hundred and fifty-six members, twenty-three small States, being just a majority of the forty-four, having altogether only seventy-two members, could decide the election—that is, the case might arise in which "less than one sixth of the members of the House, representing less than one sixth of the population of the nation, can elect the President." Further, of these seventy-two members, fifty-five could cast the votes of the twenty-three States, making the discrepancy still worse. It is not practically likely that the small States will ever combine their votes in this way, but the possibility exists.

A more imminently threatening danger to our institutions, extra-constitutional, but hardly the less binding for that, exists in the nominating convention system, which "has grown to be a monster political despotism, and in both parties is to day the absolute master of the people." Under it the people are in effect, in a large proportion of cases, deprived of all voice in the management of public affairs. It works in with several features of the law in the manner of conducting elections so as to leave helpless the voter who would be independent, and to promote the schemes of designing, dishonest men. For the latter purpose it is a most admirable instrument.

All these defects in our system of government call for some means of remedy, and the subject should be one of anxious thought to all the friends of popular institutions. Mr. Ashley's object in calling attention to them was to bring out the remedy he has devised, which he presents in the form of a series of constitutional amendments. It is not within our province to discuss the merits of his plan. We point out the need, and remark that it has engaged the serious attention of at least one earnest thinker.

Constitutions can not be made to order to last for all time. Governments, like all other things, are a growth, an evolution, are affected by the changes in the conditions of the medium, and need to be conformed to them. Conditions inevitably arise from time to time that can not be foreseen, and must be met as they appear. Our Constitution was for a long time considered nearly perfect, because it well met the conditions for which it was made. That modifications and new provisions should be found to be needed in time is not the fault of the instrument or of its makers, but a consequence of the inexorable law of evolution. While hasty and trivial tinkering are to be deprecated, the existence of that law should be recognized, and there should be no hesitation in adapting the Constitution to its workings.

PREVENTION OF CHOLERA EPIDEMICS.

If we were asked to name what in our opinion is the most important service of science to modern civilization, we should say that it consists in the means that have been given to man to prevent the spread of epidemic disease. It is not so very long ago that large cities the world over were quite unable to exclude such a disease as cholera, and when once it had gained a foothold they were wholly at its mercy until change of season or some other unexplained cause changed the conditions favorable to its spread. Attention was for centuries concentrated on methods of treatment, and down to fifty years

ago so little was known of the causes which produced the disease, or of the means of hindering its distribution, that the doctors themselves not rarely became the innocent carriers of its poison. With its cause a mystery, and resistless apparently in its advance, it is no wonder that the frightful mortality attending it struck terror to the hearts of the people among whom it appeared. But, thanks to experience and the scientific investigation of many observers, all this has gradually been changed. It has been abundantly shown both here and in England that, with suitable sanitary precautions, such as are within the reach of every enlightened community, not only cholera but other diseases which tend to become epidemic can, if taken in time, be arrested in their progress and ultimately stamped out altogether by the prompt and energetic application of ordinary hygienic rules. This is now so well understood that epidemics of any kind, particularly in centers of population under municipal control, are justly regarded as evidence of official neglect or mismanagement.

In the case of cholera the work of the sanitary authorities is really very simple. It has long been attempted to exclude the disease from cities and towns by means of quarantine, the prohibition of immigration, and of the importation of certain classes of merchandise. These measures, however, seriously conflicting as they do with the self-interest of individuals and corporations, have always proved more or less ineffective, until it has become very plain that they can not be relied upon to keep out the scourge. In England this is now generally admitted in practice, as the authorities interfere far less with commerce than formerly, but give strict attention to the immigrant and the cargo after they are landed.

The real concern of the sanitarian, then, is with the conditions of living among the masses of the people in the district under his charge, and, if past experience is any guide, his chief duty will be to promote, and, if need be, enforce the virtue of *cleanliness*, interpreting that word in its widest meaning. Filth is a necessity to the very existence of cholera. It has been the one uniform condition present in all the epidemics of which we have any record, and is the usual vehicle for the transmission of the disease. On the other hand, purity and wholesomeness are its deadly enemies, and in proportion as these are secured will the danger of epidemics decrease. Medical authorities are generally agreed that cholera is propagated by a specific poison. It matters not whether we call this a virus, a germ, or a bacillus, the important point to observe is that whatever its nature it must gain a lodgment in the system before the disease can develop. So far as known this poison or germ is only produced by the disease. It is thrown off from the bodies of the sick in the discharges from the digestive tract, and, if not destroyed at once, is ready for its career of destruction. Through defective drains or other channels it may pass into a well or stream which furnishes the drinking-water to many families. This is one of the most common ways for the poison to gain an entrance into the bodies of the healthy. Dirty food and the use of articles soiled with choleraic discharges may also convey it, but most authorities assert that it is never carried through the medium of the air—that is, the disease is contagious, but, unlike scarlet fever and measles, is not infectious. Physicians and nurses work among it with impunity, even in its most virulent form, so long as rigid cleanliness of person and clothing is observed.

The only recorded death from the disease among the attendants in Russian hospitals during the present outbreak is that of a nurse who heedlessly swallowed the remains of a cholera patient's dinner. Drinking-water, however, is by far the most frequent vehicle of the

disease, being chiefly responsible for all our most fatal epidemics. During the last London epidemic, in 1866, when the mortality rose to 904 in a single week, Dr. Farr found that the outbreak was confined mainly to the area supplied with water by the East London Water Company. This was drawn from the river Lea, which on investigation proved to be polluted. The supply was stopped, and the deaths decreased from week to week until the disease disappeared from the district. Other London districts that had suffered terribly in preceding epidemics escaped almost entirely in this one, due likewise to the improved drainage and water-supply that had been provided by the authorities during the interval.

Cases of similar import, coming to light during the present epidemic in Europe, are numerous, and equally striking.

These facts point unmistakably to the means required for limiting the spread of the disease. The strict isolation of the sick, the immediate destruction of all discharges and of any articles tainted by them, careful watchfulness concerning the purity of the water-supply of the city or district, and the use of boiled water where possible taint is suspected, with equal vigilance regarding the quality and purity of the food —in a word, the nearest practicable approach to absolute cleanliness of the person, of what he eats, drinks, and wears, and of the home and its surroundings—is the surest guarantee of safety from attack and a certain protection against the occurrence of epidemics.

To secure these important conditions in the households of the masses in our large cities something more is needed than the mere force of sanitary authority. The people themselves should be made to realize that their individual cooperation is indispensable. This may reasonably be expected when they come to understand the causes which give rise to epidemics, and the protective measures that are within their reach. The result will be hastened by adapting our public-school education a little more closely to the needs of modern life, and teaching a generation of boys and girls the simple principles of household hygiene. Dwellers in cities will then demand sanitary provisions that have now to be forced upon them, and the days of scares and mobs in the face of threatened epidemics will be over.

LITERARY NOTICES.

THE PRINCIPLES OF ETHICS. By HERBERT SPENCER. Vol. I. New York: D. Appleton & Co. Pp. 572. Price, $2.

ONE of the two volumes which form the crowning portion of Mr. Spencer's Synthetic Philosophy is now completed. It contains The Data of Ethics, previously published alone, also The Inductions of Ethics, and The Ethics of Individual Life. In the new parts of the volume Mr. Spencer first sets forth, with his usual wealth of illustration, the astonishingly various and contradictory conceptions of right and wrong which exist among different peoples. Here the unpardonable sin is disrespect of deified ancestors, there it is neglecting to kill a sufficient number of enemies; elsewhere it is *smoking!* The number of cases in which a man is thought by his fellows to be in duty bound to injure others leads Mr. Spencer to distinguish the ethics of enmity from the ethics of amity. In the stage of society in which intertribal and international wars are frequent the former actually predominates over the latter, and it is only since industrialism has largely repressed militancy that the ethics of amity has gained the ascendant. Under the three heads Aggression (by which he denotes the infliction of bodily harm), Robbery, and Revenge, Mr. Spencer specifies acts that have been required by the ethics of enmity. Thus, "far from being regarded as a crime, child-murder has been, throughout the world in early times and in various parts of the world still is, regarded as not even an offense: occasionally, indeed, as a duty." Then there are the killing of adults at funerals, especially at the obsequies of chiefs, the sacrifices of human victims to gods, and "the religious homicides

which, in comparatively modern times, have been committed, alike by Catholics and Protestants, to appease the supposed wrath of their God against misbelievers." Reducing conquered enemies to slavery is the chief of the bloodless injuries that have been sanctioned by the ethics of enmity. A closely allied form of robbery is the stealing of women, which has prevailed in all early stages of social progress. "Often where the men are killed the women are preserved to become mothers. It was so with the Caribs in their cannibal days; and it was so with the Hebrews, as shown in Numbers xxxi, 17, 18." The stealing of property has been regarded as ethical among many tribes. Coming to the subject of retaliation for injuries, Mr. Spencer finds that "among human beings in early stages, there arises not only the practice of revenge but a belief that revenge is imperative—that revenge is a duty." The persistence of dueling and the vendetta to the present day shows that this belief is not yet extinct. Yet, as societies have come into more settled social states, a spirit of forgiveness has appeared and made some growth. "The soul of goodness in things evil" must be recognized in the case of the crude idea of justice embodied in the custom of taking revenge. Even in the practice of this custom occasionally there grow up usages requiring some maintenance of equality, such as awakening sleeping foes or otherwise relieving them from a disadvantage before attacking them.

Considering in succession the virtues Justice, Generosity, Humanity, Veracity, Obedience, Industry, Temperance, and Chastity, Mr. Spencer finds abundant evidence that "the ethical sentiments prevailing in different societies, and in the same society under different conditions, are sometimes diametrically opposed," and he deems this fact enough to show that the human mind has no originally implanted conscience. "It has become clear to me," he says, "that if, among ourselves, the current belief is that a man who robs and does not repent will be eternally damned, while an accepted proverb among the Bilochs is that 'God will not favor a man who does not steal and rob,' it is impossible to hold that men have in common an innate perception of right and wrong."

A positive induction which follows from the same evidence is then set forth by Mr. Spencer in these words:

> But now, while we are shown that the moral sense doctrine in its original form is not true, we are also shown that it adumbrates a truth, and a much higher truth. For the facts cited, chapter after chapter, unite in proving that the sentiments and ideas current in each society become adjusted to the kinds of activity predominating in it. A life of constant external enmity generates a code in which aggression, conquest, revenge are inculcated, while peaceful occupations are reprobated. Conversely, a life of settled internal amity generates a code inculcating the virtues conducing to harmonious co-operation—justice, honesty, veracity, regard for others' claims. And the implication is that if the life of internal amity continues unbroken from generation to generation, there must result not only the appropriate code, but the appropriate emotional nature—a moral sense adapted to the moral requirements. Men so conditioned will acquire to the degree needful for complete guidance, that innate conscience which the intuitive moralists erroneously supposed to be possessed by mankind at large. There needs but a continuance of absolute peace externally, and a rigorous insistence on non-aggression internally, to insure the molding of men into a form naturally characterized by all the virtues.

To those who regard ethics as comprehending only the behavior of a man toward his fellows, the third part of this volume will seem superfluous, dealing as it does with actions which concern directly the actor alone, and only in remote ways affect others. But in Mr. Spencer's view, if life is a *desideratum*, then all conduct which conduces to a complete form of it is to be morally approved. On this basis he shows in successive chapters that ethics requires the individual to preserve a due balance between activity and rest, to take sufficient nourishment, to use stimulants very sparingly, to cultivate the faculties with which he is endowed, and to indulge somewhat in amusements. Finally, he discusses two subjects—marriage and parenthood—that may be called intermediate between individual and social life.

To complete the second volume of this work there still remain to be written the parts on Negative Beneficence and Positive Beneficence, and the writing of these parts Mr. Spencer "hopes to complete before ability ends." He is, he says, "especially anxious to do this because, in the absence of them, the divisions at present published will leave, on nearly all minds, a very erroneous impression respecting the general tone of

evolutionary ethics. In its full scope, the moral system to be set forth unites sternness with kindness; but thus far attention has been drawn almost wholly to the sternness. Extreme misapprehensions and gross misstatements have hence resulted."

THOMAS CARLYLE'S MORAL AND RELIGIOUS DEVELOPMENT: A STUDY. By EWALD FLÜGEL. From the German by JESSICA GILBERT TYLER. New York: M. L. Holbrook & Co. Pp. 140. Price, $1.

THIS is a clear and graceful rendering into English of Dr. Flügel's study of Carlyle. If we are not able to follow Mr. Froude in his estimation of the sage of Chelsea as indisputably the greatest man, excepting Goethe, that has appeared in Europe for centuries, we can easily subscribe to the German philosopher's opinion that he is "a moral force of great significance." Worship and work were the watchwords of Carlyle. History, science, philosophy, poetry, and art were worthless to him when divorced from ethical significance. Records and events were barren unless the historian sought in them the meaning of human life. The translator has omitted Part I, the appendix, and notes, which appear in the original; these pertain chiefly to the life of Carlyle, and are given fully elsewhere by his biographers. In the portrait attached, the philosopher looks forth dejectedly at a flippant generation.

PRIMITIVE MAN IN OHIO. By WARREN K. MOOREHEAD. New York: G. P. Putnam's Sons. Pp. 246.

MR. MOOREHEAD, one of the most active and efficient of the explorers of the Ohio mounds, who has already given in his Fort Ancient the fruit of a most thorough and exhaustive investigation, believes that exaggerated notions prevail of the civilization of the mound-builders. These exaggerated ideas are fed by the works of superficial lookers at the mounds, who in their writings do not lose sight of sensational effect, and by writers who try to uphold theories previously formed. It is the purpose of this book to do away with certain of these illusions. The author is, in fact, a little impatient that they should exist, for he says: "Why there should be so much speculation and uncertainty concerning the aborigines is inexplicable to us. No question of equal importance could have been more easily determined had the early writers given as much care and patience to mound exploration as are given at the present time." The book presents the results of four seasons of exploration, during which one hundred and seven mounds, graves, and cemeteries were opened. In every excavation careful field-notes were made on the spot, and each night the result of the day's work was fully written out. Earthworks are not included in the descriptions. The author has been assisted by Mr. Gerard Fowke, who contributed the chapter on Flint Ridge; Dr. H. T. Cresson; Mr. Jack Bennett for illustrations, sectional drawings, and ground plans, and for observations on osteological collections and palæolithic man; and Mr. W. H. Davis for a chapter on the Muskingum Valley. The descriptions relate to mounds in Licking County (Newark), the Muskingum Valley, the Madisonville Cemetery, the east fork of the Little Miami River, Fort Ancient, Clinton County, and Chillicothe and Ross County. From the results reached in the explorations, the author draws the conclusions that the tribes did not occupy the northern part of the State for any considerable length of time, but were settled chiefly in the large river valleys; that both the brachycephalic and the dolichocephalic races intermingled largely in all the valleys save the Muskingum; and that nothing more than the upper status of savagery was attained by any race or tribe living in the present State of Ohio. "If we go by field testimony alone, we can assign primitive man high attainments in but few things, and these indicate neither civilization nor an approach to it. First, he excelled in building fortifications and in the interment of his dead; second, he made surprisingly long journeys for mica, copper, lead, shells, and other foreign substances, to be used as tools and ornaments; third, he was an adept in the chase and in war; fourth, he chipped flint and made carvings on bone, stone, and slate exceedingly well, when we consider the primitive tools he employed; fifth, a few of the more skillful men of his tribe made fairly good representations of animals, birds, and human figures in stone. . . . On the other hand, he failed to grasp the idea of communication by written characters, the use of metal (except in the cold state), the cutting of stone, or the making of brick for building

purposes, and the construction of permanent homes. Ideas of transportation, other than upon his own back or in frail canoes, or the use of coal, which was so abundant about him, and which he frequently made into pendants and ornaments, and a thousand other things which civilized beings enjoy, were utterly beyond his comprehension."

THE EVOLUTION OF CHRISTIANITY. By LYMAN ABBOTT, D. D. Boston: Houghton, Mifflin & Co. Pp. 258. Price, $1.25.

DR. ABBOTT'S recent book, is more like a collection of sermons than a treatise. It has the fullness of illustration and the free indulgence in repetitions characteristic of discourses delivered to an audience that has nothing to do for the time being but listen. The gist of the book is an acceptance of the idea that the Christian religion, like all other institutions and organizations, is a growth. This idea is elaborated in successive chapters with respect to the Bible, theology, the church, Christian society, and the soul. Dr. Abbott accounts for the contradictions and imperfections which he admits exist in the Bible on the ground that the writers of the later books perceived the will of God more clearly than the men who wrote the earlier ones. He says: "The later books present higher ideals of character and conduct, clearer and nobler conceptions of God, more catholic and more positive interpretations of his redeeming work in the world, than the earlier books. The revelation is a progressive revelation. The forms, whether of religious thought, of public worship, or of church order and organization, in the Bible, are not the same; those of the later ages have grown out of those of the former ages, and are superior to them. In brief, the Bible is the history of the development of the life of God in the life of a peculiar people; and it traces the development of that life from lower to higher, and from simpler to more complex forms." The logical outcome of this doctrine is that the theologians of the present day are better able to set forth the true religion than even the writers of the Gospels and Epistles. Dr. Abbott and those who agree with him apparently retain but few things, such as the anthropomorphous nature of the First Cause, the belief in miracles, etc., that divide them from scientific moralists, and the above doctrine seems to release their successors from any obligation to retain these if they should see fit to abandon them.

THE FREE-TRADE STRUGGLE IN ENGLAND. By M. M. TRUMBULL. Second edition, revised and enlarged. Chicago: The Open Court Publishing Company, 1892. Pp. 288. Price, cloth, 75 cents; paper, 25 cents.

THIS is indeed in every respect a book for the hour. It treats at length on what is at the present the liveliest issue in the United States, from whatever point of view it may be regarded. As a historical summary of a memorable and pivotal period in English politics it is of deep political interest. Most appropriately it is dedicated to the distinguished champion of free trade, the Hon. John Bright, M. P., "the eloquent friend and defender of the American Republic, the enlightened advocate of peace and free trade among nations," and it contains a *fac-simile* autograph letter from Mr. Bright, written in 1882, in which he says, "The American tariff is so incapable of defense that discussion of the strange burden that lays upon your people can only end in some great change and great reform."

In a second letter, addressed to the author later in that year, Mr. Bright says: "I do not expect your people will copy from us; they will learn from what is passing around them how much they suffer from your present barbarous tariff. There are persons among us who are not anxious for a reform of your tariff. They say you can not have an export trade, and can not compete with us in foreign markets." In the preface to this second edition, Mr. Trumbull shows the necessary character of this particular study as a guide in our present political conditions. Citing from Mr. Whitelaw Reid's letter of acceptance, "The fact that our form of government is entirely unique among nations of the world makes it utterly absurd to institute comparisons between our own economic systems and those of other governments," our author states quite emphatically that this is "a very serious error." He does not believe any government is "unique" enough to violate the laws of moral science with impunity; that no government will ever be so "unique" as to *justly* tax one man for the benefit of another, or

forbid its citizens to buy their goods in the cheapest markets. It is because he finds every argument used by the advocates of the American system in 1884, borrowed from the speeches of the parliamentary orators in 1844, that he concludes the principles of both systems are the same, and hence they must be beneficial or injurious to one country as well as to the other. To keep the volume abreast of the debate in this country, it has been revised, and enough additional facts and arguments interwoven throughout the historical portions sufficient to make it a good campaign document. The historical portion of the book is rather well condensed from the more elaborate histories of free trade published in the Cobden Club Series and pamphlets, and it appears, upon the whole, fair and impartial. The book seems especially opportune whichever partisan reads, because logically the historical *résumé* comes before the actual discussion of free trade *versus* protection. Otherwise, how could we intelligently understand what was done, why it was done, and the circumstances which lead through so fierce a contest up to the final accomplishment? There is an excellent index, so necessary to a book of this character.

AN INTRODUCTION TO GENERAL LOGIC. By E. E. CONSTANCE JONES. London and New York: Longmans, Green & Co. Pp. 283. Price, $1.50.

THE author's purpose in preparing this work has been to provide a First Logic Book which, besides being useful in teaching beginners, may furnish a brief, connected sketch of the science, and he hopes that what he has to say may help to remove certain difficulties familiar to all teachers of logic, which have forcibly pressed themselves upon his attention in his own teaching. He here sets forth, as simply and systematically as possible, views indicated in a small book of Notes on Difficult Points in Logic which he had previously written, in which he discussed fully the cases in which he diverged from traditional doctrines, and his reasons for the divergence. He regards his scheme as following naturally from the view taken of the twofold character of terms, which, as names of things, have both application and signification. On this datum, together with the recognition that things have a plurality of characteristics and a consequent plurality of names, depends the possibility of significant assertion and the whole doctrine of inference. The principle of excluded middle suggests and supports a recognition of the relatedness of things to one another; and a consideration of Bacon's doctrine of form suggests a modification of Mill's view of induction. The relation of induction to deduction appears to be so close that it is more convenient to regard all logic as one than to make a radical and fundamental division between deductive or formal and inductive or material logic. Upon the twofold character of terms, again, depends the recognition of the law of identity as a law of identity in diversity. The author believes that his views about relative propositions, quantification, disjunctives, the force and interdependence of the principles of logic, the systematization of fallacies, and, partly, the elaboration of immediate inferences, are to some extent new.

DARWIN AND AFTER DARWIN. By GEORGE JOHN ROMANES. Vol. I. THE DARWINIAN THEORY. Chicago: The Open Court Publishing Company. Pp. 476. Price, $2.

IN the volume now before us Mr. Romanes gives a statement of the evidence which supports Darwin's biological doctrine, leaving to a second volume the discussion of post-Darwinian questions. Taking first classification, he shows that all organic Nature readily falls into an arrangement of group subordinate to group, which is just what would have been expected on the supposition that the relationships of the various species indicate lines of descent. In the field of morphology he points out the fact that where any organ gives evidence of having been modified in a certain direction, other parts of the same organism have evidently been modified to the same extent. Here also comes in the argument from vestigial structures. Some of these vestiges can be noted only during the infancy of the species, such as the form and functions of the limbs of young children. One of the illustrations in this chapter is from a photograph taken by Dr. Louis Robinson in his recent investigations on the grasping power of infants. The arguments from embryology, paleontology, and geographical distribution follow in successive chapters. A distinct division of the volume

is devoted to selection, in which the theory of natural selection is stated, and criticisms upon it are answered, and the theory of sexual selection is discussed. There is an appendix dealing with some technical points in the arguments from paleontology, and several supplementary notes. The text is illustrated with 125 excellent engravings.

PRACTICAL ETHICS. By WILLIAM DE WITT HYDE, D. D. New York: Henry Holt & Co. Pp. 208. Price, 89 cents.

THIS is one of a number of text-books that have been called forth by the recent sudden increase of interest in the teaching of ethics. Its arrangement is based on a list of objects, such as food and drink, dress, exercise, property, time, fellow-men, the poor, society, and God, and it is designed to show the proper relation of the individual to each of these objects. In each case the author sets forth the duty with regard to the relation, the virtue which secures the performance of this duty, the reward which is the natural consequence of the particular virtue, the temptation most likely to lead one away from this virtue, the vice of defective and that of excessive activity in the relation in question, and the penalty of the more common vice. The author makes religion the consummation rather than the foundation of ethics. The style of the book adapts it more especially to college students.

ETHNOLOGY IN FOLK LORE. By GEORGE LAURENCE GOMME. New York: D. Appleton & Company. Pp. 203. Price, $1.

THE study of folk lore is in the elementary stage which consists in the gathering of facts belonging to any part of its field and wherever they may be found. Mr. Gomme in the book before us has taken a step toward raising it above this stage into one in which its facts shall be grouped so as to show their hidden significance, and to point out lines of still more fruitful research. He has chosen ethnology for his special theme and marshals the available facts of folk lore so as to throw light upon the history of races. Thus, he maintains that practices and beliefs which are preserved among European peasantry, and are in marked contrast with the prevailing civilization, "are to be identified with the rude culture of ancient Europe, which has been swept over by waves of higher culture from foreign sources." The fact that such practices are most conspicuous among the descendants of a conquered race, where such exist side by side with the descendants of their conquerors, gives support to this idea. An interesting example of this is found in the village festival of southern India, in which the Pariahs—the casteless remnant of a conquered race—appear as the chief functionaries, although the dominant race takes part in it.

In a chapter on The Ethnic Genealogy of Folk Lore, evidence is presented which indicates that many beliefs and practices relating to the dead are derived from a primitive custom of eating dead kindred—a custom that still persists among some tribes of savages. There is much that now seems hopelessly obscure concerning the origin, early movements, and mingling of races, but the thorough and systematic study of folk lore, in such lines as those that Mr. Gomme has traced, promises to throw light into many dark places.

THE WIFE AND MOTHER. By ALBERT WESTLAND, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 282. Price, $2.

THE author states in his preface that "this work is addressed to women who are desirous of fulfilling properly their duties as wives and mothers, and is designed to assist them in exercising an intelligent supervision over their own and their children's health." It is a notably full and thorough treatise, dealing with all the incidents of pregnancy and confinement, describing the proper care of the infant, and telling how the common diseases of children may be recognized. The accidents of miscarriage and premature confinement are described, and the extra precautions which they necessitate are specified. In the part devoted to the child, one chapter tells the average size and weight of the child at birth, the usual rate of growth, at what age the teeth appear, the power of walking is developed, and the ability to talk is gained. The style of the book is simple and concise; it is not marred by useless words or mystifying technicalities. The author takes especial care to tell what may be expected to occur during the period of gestation and after the birth of the child, giving the range of

variation that is noticed in different persons. With this information the mother need have no alarm when unaccustomed sensations are felt, or if she or her child do not do exactly the same as her friend and her friend's child have done. The book does not attempt to take the place of a physician, but tells, under the various divisions of its subject, what symptoms require that a physician should be called.

PAGANISM SURVIVING IN CHRISTIANITY. By ABRAM HERBERT LEWIS, D. D. New York: G. P. Putnam's Sons. Pp. 309.

THE efforts of partisans, the author of this book says, to manipulate early history in the interest of special views and narrow conceptions have been a fruitful source of error. Equally dangerous has been the assumption that the Christianity of the third, fourth, and fifth centuries was identical with that of the New Testament, or was a fair representative of it. The constant development of new facts shows that at the point where the average student takes up the history of Western Christianity it was already fundamentally corrupted by pagan theories and practices. Its unfolding from that time to the present must be studied in the light of this fact and the rise, development, present status, and future history of Roman Catholicism and Protestantism can not be justly considered independently of it. The fundamental principles and the underlying philosophy of these divisions of Christendom originated in the paganizing of early Christianity. This fact makes the re-study of the beginnings of Christianity of supreme importance. The book presents a suggestive rather than an exhaustive treatment of these influences, and of their effect on historic Christianity, in the four points of the influence of pagan thought upon the Bible and its interpretation; upon the organized Church, through the pagan water-worship cult; upon the practices and spiritual life of the Church, "by substituting pagan holidayism for Christian Sabbathism"; and upon the spiritual life and subsequent character of the Church, by the union of church and state, and the subjugation of Christianity to the civil power, according to the pagan models. Under the first of these headings came the corruptions derived from gnosticism and various allegorical interpretations of scriptural doctrines and symbols; under the second the corruptions of Christian baptism, giving rise, among other things, to the doctrine of baptismal regeneration and the use of holy water; under the third, the origin of the substitution of Sunday for the old Sabbath, and the rise, purpose, and tendency of Sunday legislation—to which the author is opposed, on principle and as a Seventh-day Baptist; and under the fourth the whole course of secular interference with the Church. "Other forms of pagan residuum in Christianity" include a low standard of religious life; the metamorphosis of an ancient phallic emblem into the Christian cross; various beliefs connected with baptism; lights in worship; the eastward position; certain features peculiar to the Roman Catholic Church; and the observance of certain Christianized pagan holidays. Regarding the fundamental principles of Protestantism, as involved in present issues, the author concludes that Protestants must accept the Bible in fact as well as in theory, reinterpreting it in the light of "higher criticism" and deeper spiritual life, or be overthrown; that baptism must cease to be the football of denominational polemics and be raised to a question of obedience to the example of Christ; that Protestants must return to true Sabbathism, "which is as undenominational as faith"; and that all union of Christianity with the state must yield before the normal development of true Protestantism.

ELEMENTS OF PHYSICS. By C. E. FESSENDEN, Principal, Collegiate Institute, Peterboro, Ontario. London and New York: Macmillan & Co., 1892, Pp. 229. Price, 80 cents.

THIS is the latest of the excellent series of text-books in science published by Messrs. Macmillan & Co. It is especially worthy of the attention of educators, on account of its simplicity and the natural method of instruction, scientific accuracy of statement, clean text, type, and admirable illustrations. The four simple divisions are: Matter and its Properties, pp. 1–53; Kinematics, pp. 53–64; Dynamics, pp. 64–179; Heat, pp. 179–229.

One is inclined to envy a generation of beginners in science to whom each step is so clearly explained, and where the illustrations really assist the student. The longest chapter, very properly, is devoted to the impor-

tant subject of dynamics, of which the illustrations are profuse and varied. At the end of each chapter there are well-planned questions designed to test the originality and thought of the beginner, and throughout the book many problems, carefully selected, add to its value.

SIX BOOKS OF THE ÆNEID OF VERGIL. By WILLIAM R. HARPER, Ph. D., President of the University of Chicago, and FRANK J. MILLER, Ph. D., Instructor in Latin in the University of Chicago. American Book Company: New York, Cincinnati, Chicago. Pp. 461. Price, $1.25.

THIS is a school edition of the great Mantuan bard, prepared with judicious zeal and with the intention of exciting in the youthful student of Latin poetry a genuine love for the most eminent poet of ancient Rome. The bibliography is a unique but complete feature, and exceedingly well arranged. The extracts from ancient and modern poets are quite extensive for so small a text-book. There are eleven full-page photographic illustrations, all from such historic pictures as The Death of Laocoön, Ceres, The Cumæan Sibyl, etc., with Raphael's portrait of Vergil, and a map of the scene of the hero's wanderings on land and sea. The Topics for Investigation, the Testimonies to Vergil's Worth as a Poet, and the Inductive Studies, copied and condensed from the best classical commentators, form a particularly interesting feature of the book.

A copious Vergilian vocabulary, word-list, and concise foot-notes, giving instances of paraphrases of Vergilian lines in modern poets, add to the vivid character of the book and render attractive the lines of the poet, who is ever young because ever studied and always admired. Among the many editions of Vergil, we know of none in size, illustrations, type, scholarship, scope and quality of the work done, more suitable to be put into the hands of the young American student. Those of us who remember the old texts, scant notes (none plain), and who recall the beauties to be discovered without help or hint, and who were expected to discourse on grammatical puzzles like German scholiasts, can well understand why the present generation ought to read more Latin poetry in less time, understand it better, and enjoy it more than the students of thirty years ago. Even Tennyson's stately tribute on the nineteenth centenary of Vergil's death finds here an appropriate place:

"Light among the vanished ages; star that gildest yet this phantom shore;

. . . . . .

I salute thee, Mantovano, I that loved thee since my day began,
Wielder of the stateliest measure ever molded by the lips of man."

THE HIGH-SCHOOL ALGEBRA. American Book Company. Pp. 360. Price, $1.

THIS is a revised and enlarged edition of Prof. Milne's Inductive Algebra, already well known as a clear and widely used work. The present edition is prepared to meet the want of the improved method of teaching, and to keep pace with the advanced work demanded for high schools and advanced standing in colleges. Besides the chapters on Radical Quantities, Radical Equations, and Quadratic Equations, there are a general review and special chapters on Imaginary Quantities, Indeterminate Equations, Inequalities, Logarithms, the Binomial Theorem, Undetermined Coefficients, and the Theory and Transformation of Equations, which many of our modern algebras for schools seem to have lost sight of or completely ignore.

PAUPERISM: A PICTURE, AND THE ENDOWMENT OF OLD AGE. An Argument by CHARLES BOOTH. London and New York: Macmillan & Co., 1892.

IN studying some records, kept for thirteen years, of poverty at Stepney in 1889, Mr. Booth came across written records of parochial relief, and from them he draws these pictures of pauperism as seen in certain portions of London, notably at Stepney and St. Pancras, and incidentally discusses one phase of English pauperism, viz., Old Age and its Remedies. The book is one of social science study, filled with statistics, personal data, and an account of the causes usually assigned for pauperism—crime, drink, extravagance, sickness, lack of employment, miserable surroundings, vice and criminality, laziness, early marriages and large families, death of parents, old age.

Stripped of a mass of unnecessary statistics, the pith of the book occupies eight pages, Chapter VII, in which the particular phase of old age pauperism, according to Mr. Booth, is not desirably treated in England.

The indoor relief lacks humanity and the outdoor relief encourages improvidence. Mr. Booth therefore suggests a universal compulsory system of state aid supported by taxation—a sort of pension, beginning, at the age of sixty-five, at five shillings per week for the central class of English workingmen, which he computes at one fourth of the whole number. The vagueness of this demand is tacitly admitted by our author when he grants that such questions might be asked as, Have the people at large made any such demand? Have they any grievance on this subject which calls for redress? Would they be willing to be taxed to provide pensions for the old? We all know how thoroughly the social science associations of England have discussed all phases of the pauper question in the United Kingdom, and of the plans of relief past and present proposed. The name is legion. Rich and poor are now taxed to this end, indirectly if not directly; and it were extremely doubtful, if Mr. Booth's plans were not less direct than his well-known zeal and warmth of heart and interest in the cause of humanity, whether it would avail more for the subject he has at heart than this well-written, well-intentioned, but rather imperfect book.

DISTINCTION AND THE CRITICISM OF BELIEFS. By ALFRED SIDGWICK. London and New York: Longmans, Green & Co. Pp. 279.

THE object of this book is chiefly to seek the means of giving more accurate and adequate expression to our thoughts. In the discussion of many questions we come to points where we are at loss concerning the exact significance of the terms we use, or to find words clearly to mark our thought. This is because many important and necessary terms involve ambiguity, leaving, at the best, doubt as to the precise sense in which they are to be taken. One of the first things to ask is, what we shall mean by ambiguity. An ambiguous word may be roughly defined as a word with two or more meanings; it is not, however, the bare fact that a word has two or more meanings that makes it ambiguous in any effectual sense, but the fact that its two or more meanings are in practice confused. The author in his argument attempts, first, to discover the part that is actually played by ambiguity (or rough distinction) in confusing our judgment. In the process of getting to understand exactly the error that rough distinction creates, it becomes necessary to discuss the excuses that may sometimes be made for vagueness. At every level of our thought we are soon brought up against the difficulties that arise out of the attempt to define our words—or to draw sharp distinctions where the things distinguished shade off into one another—difficulties familiar to every one. Hence the author's purpose includes an attempt to find a more philosophical method of dealing with rough distinctions, in place of the happy-go-lucky tact that every one uses, more or less, by the light of Nature; and in connection with this a considerable number of questions arise, and suggest lines of further inquiry. Another interwoven subject is the everlasting struggle that language carries on against difficulties of expression. A third incidental subject is the way in which language acts as a drag upon the progress of knowledge, doing this through "a certain over-conservative tendency in our thought" that keeps us more under the slavery of words than we need be.

Cathcart's Literary Reader, compiled by *George R. Cathcart*, and first published eighteen years ago, now appears in a revised edition (American Book Company, $1.15). It combines the function of an advanced reading-book with that of a manual of English literature. Besides the selections from writers of the Elizabethan period, the Commonwealth and the Restoration, the eighteenth century, and the nineteenth century, the book contains introductory remarks on each epoch, biographical and critical information concerning the authors represented, explanatory foot-notes, and a large number of portraits. While poetry, oratory, and fiction make up the body of the selections, history and modern science are not ignored.

PUBLICATIONS RECEIVED.

Ayers, Howard. The Ear of Man: its Past, its Present, and its Future. Pp. 44.—The Vertebrate Ear (Journal of Morphology for May, 1892). Pp. 334, with 9 Plates. Both Boston: Ginn & Co.

Benwell, J. Leon. The Religion of Humanity: a Philosophy of Life. Buffalo: H. L. Green. Pp. 28.

Benney, G. E. Induction Coils. New York: Macmillan & Co. Pp. 231. $1.

Burke, Charles G. Cosmography and the Cosmograph. New York: Peck & Snyder. Pp. 24.

Byers, J. W., M. D., Charlotte, N. C. The Metschnikovian Theory of Vital Resistance. Pp. 15.

Chamberlain, A. F. The Language of the Mississagas of Skūgog. Philadelphia: MacCalla & Co. Pp. 84.

Church, Rev. A. J. Pictures from Roman Life and Story. New York: D. Appleton & Co. Pp. 314. $1.50.

Caldwell, G. C. Elements of Qualitative and Quantitative Chemical Analysis. Philadelphia: P. Blakiston, Son & Co. Pp. 175.

Day, David T. Report on Mineral Resources of the United States, 1889 and 1890. Washington: United States Geological Survey. Pp. 671. 50 cents.

Dobbin, Leonard, and Walker, James. Chemical Theory for Beginners. New York: Macmillan & Co. Pp. 240. 70 cents.

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Garner, R. L. The Speech of Monkeys. New York: Charles L. Webster & Co. Pp. 217.

Giffen, Robert. The Case against Bimetallism. New York: Macmillan & Co. Pp. 254.

Haskins, Caryl D. Transformers: their Theory, Construction, and Application, simplified. Lynn, Mass.: Rubier Publishing Co. Pp. 150. $1.25.

Huston, H. A., Purdue University, Lafayette, Ind. Commercial Fertilizers. Pp. 14, with Chart.

James, Joseph F. The Preservation of Plants as Fossils. Pp. 4.

Japan, Imperial University of, Calendar for 1890–'91. Pp. 259.—Ditto for 1891–'92. Pp. 274, with Charts.—Journal of the College of Science. Pp. 48, with Charts.

Johnson, Amy. Sunshine. New York: Macmillan & Co. Pp. 502. $1.75.

Johnston, Richard Malcolm. Mr. Fortner's Marital Claims. New York: D. Appleton & Co. Pp. 182. Paper, 50 cents.

Jones, E. E. C. An Introduction to General Logic. London and New York: Longmans, Green & Co. Pp. 283. $1.50.

Kirby, W. F. Elementary Text-book of Entomology. New York: Macmillan & Co. Pp. 272, with 86 Plates. $3.

Koehler, S. R. White-line Engraving for Relief-printing in the Fifteenth and Sixteenth Centuries. Washington: United States National Museum. Pp. 16.

Lake Publishing Company, Toronto, Ont. The Lake Magazine, August, 1892. Pp. 64. 25 cents; $2.50 a year.

Leland, Charles G. Leather Work: a Practical Manual for Amateurs. New York: Macmillan & Co. Pp. 96. $1.50.

Merrill, G. P., and Packard, R. L. An Azure-blue Pyroxenic Rock from the Middle Gila, New Mexico. Pp 2.—On some Basic Eruptive Rocks in the Vicinity of Lewiston and Auburn, Maine. Pp. 9.

Millar, C. C. Hoyer. Florida, South Carolina, and Canadian Phosphates. New York: The Scientific Publishing Co. Pp. 217. $2.50.

Peterson, Frederic, M. D. Wintering in Egypt. New York. Pp. 16.

Physical Education. July and August, 1892. Springfield, Mass.: The Triangle Publishing Co.

Psychical Research, Proceedings of the Society for. July, 1892. London. Pp. 220.

Poor, John Alfred and Laura Elizabeth. The First International Railway and the Colonization of New England. New York: G. P. Putnam's Sons. Pp. 400. $3.

Salters, William M. First Steps in Philosophy. Chicago: Charles H. Kerr & Co. Pp. 156. $1.

Schoenhof, Jacob. The Economy of High Wages. New York: G. P. Putnam's Sons. Pp. 414. $1.50.

Sidgwick, Alfred. Distinction and the Criticism of Beliefs. New York: Longmans, Green & Co. Pp. 279. $1.75.

Stevenson, Thomas, and Murphy, Shirley F. A Treatise on Hygiene and Public Health. Philadelphia: P. Blakiston, Son & Co. Pp. 1013.

Torrey, Bradford. The Foot-pathway. Boston and New York: Houghton, Mifflin & Co. Pp. 245. $1.25.

Town Topics, Tales from. New York: Town Topics Publishing Co. Pp. 219. 50 cents.

Ward, Lester F., Washington, D. C. The Plant-bearing Deposits of the American Trias.—Geological Correlation by Means of Fossil Plants.—The Science and Art of Government.—A National University. Pp. 6 in all.

POPULAR MISCELLANY.

Leather-splitting and Shoe-pegging Machines.—We have received from Mr. Charles H. Parker, of Billerica, Mass., an interesting statement of the claims of Mr. Samuel Parker, of that place, born in 1772, died in 1841, to be regarded as the inventor of the leather-splitting machine. Mr. Parker was the son of a tanner, and displayed considerable genius, which he applied in secret and in the face of many obstacles to the construction of his machine. To test its usefulness he experimented upon it with some leather from his father's tan-yard, and found to his great delight that it did the work it was invented for. A patent was granted to him for the invention, July 9, 1808. The original machine was burned with the tan-yard buildings about forty years ago. Mr. Rich, author of the article in the Monthly on leather-making, says that the historical statements concerning Mr. Parker's invention are correct, and that he probably did as much as any of the early workers in realizing the invention, and is to be credited as a pioneer. The case appears to be one of that numerous class in which many inventors contribute to the perfection of a machine, each furnishing his quota of suggestions for its better working, while the one who produces a machine recognized as practical and puts it on the market gets the credit and profit of the whole.—Mr. J. J. Greenough, of Fort McPherson, Atlanta, Ga., writes us to dispute the claim of A. C. Gallahue to be the inventor of the pegging machine. It appears from Mr. Greenough's letter that he was first to file an application for a patent on such a machine, in 1852, and Mr. Gallahue after-

ward filed an application which interfered with it. This application was amended in order to avoid the interference, and patents were granted on both; but that Greenough's is the parent of the modern machine, while Gallahue's "did not contain a single feature" of it, except the pegging-awl and driver; while "there is not an essential feature in the present shoe-pegging machine which is not found" in the Greenough claims. The details of the dispute, as Mr. Greenough gives them, are intricate, and we can do no more than fairly state the substance of his claim.

The American Association, 1893.—The next meeting of the American Association (1893) will be held in Madison, Wis. The following are the officers-elect: President, William Harkness, Washington; vice-presidents, A, Mathematics and Astronomy, C. L. Doolittle, South Bethlehem, Pa.; B, Physics, E. L. Nichols, Ithaca, N. Y.; C, Chemistry, Edward Hart, Easton, Pa.; D, Mechanical Science and Engineering, S. W. Robinson, Columbus, O.; E, Geology and Geography, Charles D. Walcott, Washington; F, Zoölogy, Henry F. Osborn, New York; G, Botany, Charles E. Bessey, Lincoln, Neb.; H, Anthropology, J. Owen Dorsey, Tacoma, Md.; I, Economic Science and Statistics, William H. Brewer, New Haven, Conn.; permanent secretary, F. W. Putnam, Cambridge (office, Salem), Mass.; general secretary, T. H. Norton, Cincinnati, O.; secretary of the council, H. L. Fairchild, Rochester, N. Y. Secretaries of the sections: A, Mathematics and Astronomy, Andrew W. Phillips, New Haven, Conn.; B, Physics, W. Le Conte Stephens, Troy, N. Y.; C, Chemistry, J. U. Nef, Chicago, Ill.; D, Mechanical Science and Engineering, D. S. Jacobus, Hoboken, N. Y.; E, Geology and Geography, Robert T. Hill, Austin, Tex.; F, Zoölogy, L. O. Howard, Washington; G, Botany, F. V. Coville, Washington; H, Anthropology, Warren K. Moorehead, Xenia, O.; I, Economic Science and Statistics, Nellie T. Kedzie, Manhattan, Kan.; treasurer, William Lilly, Mauch Chunk, Pa.

Prehistoric Copper Implements.—In a paper at the American Association, on Singular Copper Implements from the Hopewell Group, Ross County, Ohio, Prof. F. A. Putnam emphatically denied the statements that these copper implements were fashioned by white men and given to the Indians in trade. "It must be," said he, "that these implements were made by the native Americans. In all cases where implements and ornaments are found in these mounds, there are found also on the altars nuggets of copper. So it is with the silver implements and those made of meteoric iron. Now, is it likely that the trader would furnish the Indian with nuggets of the natural material? There is conclusive proof that the original settlers of the Ohio Valley worked the metal into these implements and ornaments. Again, these mounds, many of them, have trees growing on them that are between four hundred and five hundred years old. This carries back beyond the time of trading." Prof. Putnam explained that round holes could be cut in the sheet copper which had been hammered out by the Indian, by simply placing the sheet of copper on the trunk of a tree and pounding into it one end of an oak limb squared. He was unable to describe the probable mode adopted by the Indians in cutting edges shaped like the teeth of a saw, but thought it was done by the use of an instrument made of meteoric iron.

Sir Archibald Geikie on the Age of the Globe.—The address of Sir Archibald Geikie, as President of the British Association in Edinburgh, included a historical review of the Huttonian and Wernerian theories of the origin and processes of geological changes, and closed with an examination of the present state of opinion and evidences concerning the age of the globe. While the speaker regarded the demands of the earlier geologists for unlimited time for the formation of the earth's strata as extravagant, he was equally of the opinion that the limitations which the physicists seek to impose on the duration of the processes need to be revised. The rate of degradation of the land under atmospheric influences is capable of measurement, and from this it is concluded that the geological deposits, if they were all made at the most rapid rate witnessed, would require seventy-three millions of years; if at the slowest rate, six hundred and eighty millions of years, for their accumulation. But it may be argued that all kinds of ter-

restrial energy are growing feeble, that the most active denudation now in progress is less vigorous than that of bygone ages, and hence that the stratified part of the earth's crust may have been put together in a much briefer space of time than modern events might lead us to suppose. But no confirmation of this argument can be gathered from the rocks. We can see no proof nor any evidence that suggests that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic times than it is to-day. A yet further and impressive body of evidence is furnished by the successive races of plants and animals which have lived upon the earth and have left their remains sealed up within its rocky crust. We have no data as to the rate of this evolution, but only the negative evidence that it has made no visible progress since man began to observe and record. And when we look beyond the narrower range of human history at the remains preserved in even the most recent geological strata, we encounter the most impressive proofs of the persistence of specific forms. After careful reflection on the subject, the speaker affirmed that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which can not be satifactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.

Chaga (Mount Kilimanjaro) and its Inhabitants.—Chaga, or the temperate region of Mount Kilimanjaro, according to Dr. W. L. Abbott, extends a distance of about sixty miles, and is inhabited by a population of sixty thousand. At no point does the cultivation extend lower than three thousand feet, and nowhere above five thousand four hundred feet. This narrow zone is from two to four or five miles wide. It is divided into some thirty states, each governed by a more or less independent sultan, and separated from its neighbors by a strip of wilderness or a deep gorge. The largest state, Mechame, contains probably ten thousand people, while some of the lesser states have only a hundred or two subjects. The state of Useri is governed by Malimia, an energetic sultan who is rather shy of strangers, having a fear of being bewitched. The Sultan of Marang, Miliari, is a great friend of the Europeans. Fumba, the chief of Kilimma, is remarkable for his hugging habits, which make him an extremely unpleasant host. In Moshi, the Sultan Mandara has had more intercourse with strangers than any other chief, and has accumulated European curiosities of every imaginable description—toy steam-engines, clocks, guns of many patterns, stereoscopes, sewing machines, cavalry helmets, books, uniforms. Cena, the Sultan of Kibosho, is the most powerful chief on the mountain, and seems to hold his own, with all the other states allied against him. He is very friendly toward Europeans, and is liberal in his presents of cattle, etc., to those favored visitors. He has constructed a large series of underground passages or galleries beneath his *boma* or stockades. The huts are arranged in a circle, and a sloping shaft leads down from the floor of each hut. From this main gallery another runs off to open out upon a hill-side several hundred yards distant. By means of this arrangement his wives and cattle would be able to escape in case of a surprise or sudden attack. Two hundred warriors keep nightly guard around his house. Many women of Mandara's harem would be beauties in any country, in spite of their dark skins.

Prof. Le Conte on the Origin of Niagara Falls.—Explaining his views of the origin of Niagara Falls at the excursion of the American Association to that place, Prof. Joseph Le Conte said that, as the ice-sheet was pushed slowly backward after the conclusion of the Glacial period, the first of the lakes to be uncovered was Lake Erie. "After that the ice was pushed back from the other lakes. When Lake Ontario was uncovered, the ice was still upon the St. Lawrence River, and the lake had no outlet in that direction as it has at present. It was for this reason that the waters of the lake rose to such a height, and formed the Iroquois beach which extends along the lake to Rochester in what is known as the Ridge Road. It is my opinion that at this period Lake Ontario was drained off through the Mohawk Valley by the Mohawk River, and thence by the Hudson River to the sea. About that time the Niagara River

began to cut its way year after year, century after century, millennium after millennium. As the waters of Lake Ontario began to subside, the height of the Falls increased. The upper stratum of rock is Niagara limestone, a hard rock, but beneath it is a stratum of Niagara shale. It is the slow undermining of this shale that causes the Niagara limestone rock to break off from year to year and the Falls to recede. How long it has taken the Falls to go back from Lewiston I do not know. They are going now at the rate of three or four feet a year. At that rate some ten or twelve thousand years would have done the work. The lowest estimates are from seven to eight thousand years. I for my part am inclined to favor the higher estimate. Well, they are still going backward. What will be the final result? They may go back to the lake; but the Niagara limestone is growing thicker and thicker, and may finally extend to the bottom of the fall. In that case the rock would not break off, but would wear away and form a rapids. In any case, if the Falls should recede to Lake Erie, at the present rate it would take at least twenty thousand years, and, of course, we can not be very strongly personally interested."

Cause of Seasickness and Remedies for It.—The inducing cause of seasickness, according to the studies of Dr. Herbert Damvers, is a mechanical irritation of the walls of the stomach due to contact of parts not usually in apposition with one another. The effect of this is to produce reflex stimulation of the vomiting center in the medulla and directly a subacute gastritis; diminished blood-supply to the head and neck (as seen in the extraordinary pallor of the face); and a disturbance of cerebral circulation, resulting in a general nerve starvation, which is evidenced by headache of neuralgic intensity. The author would for clinical purposes group all cases into three divisions, according as head symptoms or gastric symptoms largely predominate, or head and gastric symptoms are combined in nearly equal degrees (mixed cases). The author treats cases of the first group with enemas, followed by nerve sedatives, and then with measures to raise depressed spirits. In cases of the second group he administers warm water as an emetic, followed by prescriptions for allaying gastric irritability. For the mixed cases soda and compound tincture of cardamoms or nitromuriatic acid during the day, with a pill of calomel, colocynth, and hyoscyamus at bedtime, have been found efficient. These methods of treatment apply solely to large ocean steamers, on which the passengers remain a week or more. In the case of short trips on small vessels, in which the motions are different, the author is sure that we have no drug or combination of drugs that will act as a panacea.

Biological Teaching in American Colleges.—Reviewing the present condition of biological teaching in the colleges of the United States, Prof. John A. Campbell remarks that we have now advanced to a stage where we can no longer expect much biological research to be done by private persons, and must look largely to the colleges for work of a purely scientific character. Many problems are peculiar to the country, arising out of the character of its flora and fauna; while, on the other hand, certain kinds of work find in this country more favorable conditions than prevail elsewhere. Much is still to be done in purely descriptive work. There are many regions to be explored before we will know the entire flora and fauna of the United States, and our knowledge of the life histories, especially of the lower vegetable forms, is in a peculiarly unsatisfactory condition. Co-operation among investigators is especially necessary if the best results to the individual are to be reached; while specialization of research is equally imperative for the best interests of science. At present, in this country, these two points are not equally guarded, for we do not find sufficient efforts made to resist the narrowing tendency of specialization. Prof. C. O. Whitman has pointed out the necessity for organization among investigators, and as a result of his efforts there is a much more wide-spread appreciation of this necessity than ever before. There have been advanced lecture courses and courses and co-operative studies in current literature at Johns Hopkins University ever since its foundation. In but few other institutions do the catalogues contain any accounts of such work. But the present indications are hopeful. The necessity for the work is coming

to be generally felt, and the means to do it will assuredly follow. The colleges seem to be doing too little to advance the sum of knowledge in the direction of biology. Few of them are equipped for research; and in a large proportion of them the professors of biology are handicapped by having other work to do not connected with their department.

The Moss Sponge of an Alaskan Forest.—In the interior plateau of the Cordilleran and St. Elias regions of Alaska, according to Mr. C. W. Hayes, surface degradation is greatly retarded by the luxuriant growth of moss, which covers practically the entire surface of the country. The annual precipitation is largely confined to the winter months, and the water from the melting snow is held by the sponge-like moss, which remains saturated throughout the short but hot and dry summer. Thus, with a rainfall which in lower latitudes would condition an arid region, a large part of the surface is swampy, quite irrespective of slope—that is, wherever the material composing it is sufficiently compact to become impervious to water on freezing. On account of this slow and imperfect surface drainage, the slopes are not cut into the ravines and arroyas so characteristic of arid regions.

Orography of the Mount St. Elias Region.—From the vicinity of Frazer River, in southern British Columbia, says Mr. C. W. Hayes, in his Expedition through the Yukon District, the western mainland range of the Cordilleran mountain system follows the coast toward the northwest as far as the head of Lynn Canal. Here it becomes an interior range, while to the westward its place next the coast is taken by the St. Elias range. The southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which none perhaps have an altitude of more than eight thousand or nine thousand feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated varying distances by numerous deep fiords. From the head of Lynn Canal northwestward the range decreases in altitude and probably spreads out and merges in the broken plateau which occupies the eastern part of White River basin. The elevation of the interior plateau, where it is crossed in passing from the Taku to Lake Ahklen, is about five thousand feet above sea-level. From this point it descends gradually toward the northwest. Southwest of Selkirk the same plateau extends with gradually increasing altitude to the base of the St. Elias Mountains. It is only in a general way, however, that these areas are to be regarded as plateaus. When considered in detail, the surface is extremely rough and broken. The river valleys lie from two thousand to twenty-five hundred feet below the general plateau level, while broad and rounded dome-like summits and a few sharp peaks rise from seven hundred to twelve hundred feet above it; but there appear to be no well-defined ridges or chains of peaks. For about one hundred and fifty miles southwest of Selkirk the contours are generally smooth and flowing, and the surface, except in the glaciated portion of the region, shows the effect of long-continued exposure to the action of subaërial agencies.

The Geological Collection of the National Museum.—In the arrangement of the geological collections of the United States National Museum, as described in Curator George P. Merrill's Hand-book, the wants of the specialist of facilities for study, and those of the public, in whom it is desired to arouse an interest in natural phenomena, have both been consulted. An exhibition is set up of series arranged and labeled for the general public, and accessible at the same time to the student and specialist, and a study series is stored away in drawers. The exhibition series is treated essentially according to the plan given by Prof. Geikie in the latest edition of his text-book on geology; conforming to Mr. Goode's suggestion that a museum should consist of a collection of labels illustrated by specimens, the curator has striven "to build up the exhibition series on the plan of a profusely illustrated text-book, in which the specimens themselves form the illustrations, and the text is furnished by the labels." No object has been intentionally exhibited merely on account of its beauty, rarity, or curiosity

Each, intended to illustrate some special point, forms a part of a more or less extended series tending toward the elucidation of the earth's structure and history. In the section of Systematic Geography, for instance, the several departments are devoted to the consideration of the materials of the earth's surface; to dynamical and physiographical geology, including the action of various agencies—heat, compression, tension, fracture, air, water, ice, life, etc.; to structural geology, or the architecture of the earth's crust — including stratification and its accompaniments, joints, inclination, strike, dip, igneous effects, and veins; and to stratigraphical or historical geology. The section of Economic Geology is arranged in a similar manner for illustration by specimens of building and ornamental stones, ores, and other useful mineral substances.

Relative Value of Rain and Irrigation. —Chief Fernow remarks, in his report of the Division of Forestry, that the manner in which the water of the atmosphere becomes available — rain — is not the most satisfactory. This because of its irregularity, and on account of its detrimental action in packing the ground and impeding percolation. A large amount of what would be carried off by underground drainage is thus changed into surface-drainage waters. At the same time, by this compacting the soil, capillary action is increased, and evaporation thereby accelerated. Water management, or forest management as a part of it, may be profitably studied in connection with this subject. The forest floor reduces or prevents the injurious mechanical action of the rain, and acts as a regulator of water-flow. Hitherto water management in rainy districts has mainly concerned itself with getting rid of the water as fast as possible, instead of making it do service during its temporary availability by means of proper soil management, horizontal ditches, and reservoirs—drainage and irrigation systems combined. It seems to have been entirely overlooked that irrigation, which has been considered only for arid and subarid regions, can be applied for plant production in well-watered regions with equal benefit and profit, if combined with proper drainage systems and forest management. To pave the way for a better utilization of water-supplies in the Eastern States seems as much a proper function of the Department of Agriculture as the development of irrigation systems in the Western States; and a comprehensive collection of water statistics and forestry statistics with reference to their mutual relation seems to be a desirable task.

The Public School and the University. —The policy adopted several years ago by the University of Michigan, of admitting graduates of the public schools of the State without examination, is represented by the University Record as working well. The faculty feel that, whatever may be the defects of the diploma system, there are gains that more than counterbalance them. The principal gain has been in strengthening the bond between the university and the high schools. Experience goes to show that voluntary initiative of the university and the schools can make good to a great degree the lack of an authoritative State surveillance of public instruction. In many ways the university has been able to exert a salutary influence upon the schools, while its own position before the people of the State has been very greatly strengthened by the system; and this has been done without lowering the standard of scholarship.

Graphite and Lead-pencils. — The ancients were not acquainted with any real drawing lead. The first drawings resembling those made with a pencil appeared in the later middle ages. Silver-pencil drawings by Van Eyck and Memlink are spoken of; the portrait of Petrarch's Laura was made by a contemporary in a similar style; and Michael Angelo sometimes drew with pencils that seem to have been made of a compound of lead and tin. These were exceptions to the general rule. Pens, crayons, and red chalk held the place among artists and in general use now occupied by the pencil. The famous graphite beds of Borrowdale, in Cumberland, were discovered during the reign of Queen Elizabeth in England, and with them the material which was destined to stimulate the rapid development of the pencil industry. Our lead-pencil is really a graphite pencil. The pencils made in England then were quite different from the products of the pres-

ent manufacture. The graphite was sawed into small sticks and these were inclosed in wood. The Cumberland pencil was regarded till about the beginning of our century as unsurpassed, distinguished by an extraordinary softness and delicacy in the drawing, and was extremely costly. Only the best and purest material being used, this was exhausted in a relatively short time, without any new source being discovered. At last, manufacturers began to pulverize the waste and to mix it with other materials, to press the mass into hard cakes and saw it up in the old way, without getting a pencil in any way comparable with the old Cumberland brand. New beds of graphite were, however, discovered in Bohemia, the product of which was still far inferior to that of Borrowdale. After some time the art was learned of purifying the Bohemian graphite by a careful chemical process; and toward the end of the last century the happy thought occurred at once to a French and a German manufacturer of mixing purified graphite, finely ground, with moistened clay. The invention was useful in three ways: by reducing the cost of the pencils without impairing their quality; by making it possible, through variations in the proportions of the ingredients, to give the pencils different degrees of hardness; and by simplifying the manufacture, so that pencils became cheap and within the reach of all.

Native Types in Abyssinia.—Traveling in Abyssinia, M. Jules Borelli was most struck with the multiplicity of the native types, and, in fact, with the entire absence of a pure type. Thus, it seemed impossible to find a regular Abyssinian type at Shoa. This is possibly accounted for by the fact that four fifths of the people at least are the sons of slaves of various origins. The sons of the daughters of nobles, who pretend to be of the pure race, are most frequently grandsons of slaves. In many places cloths and articles of silver were found, bearing designs that pointed to an Oriental origin, which seemed to indicate that, long before the rise of Islam, southern Arabia was occupied by Persians. These were the first Asiatic races which, passing the Red Sea, drove back before them the black races, while they mingled with them, forming those innumerable varieties which now make a classification of native types impossible. The multiplicity of languages spoken in these regions is another consequence of these invasions and crossings.

Glacial Moraines in Illinois and Indiana.—In a paper on the Glacial Phenomena of Northeastern Illinois and Northern Indiana, Mr. Frank Leverett describes the moraines as terminal to the ice, but not to the drift-covered areas of those States. Four proofs of advance in the production of later moraines are cited: Buried soils *in situ* between till sheets; changes in the direction of flow as shown by striæ; change in the form of the ice lobe, as indicated by the distribution of the morainic belts and the shiftings of the re-entrant and lobate portions; and evidence of push or advance found in the moraine itself. The number of distinct moraines varies because of partial coalescence or local obliteration of portions of certain moraines by later advances. For this reason correlation is difficult. Aside from this, there is an increase in complexity in passing from older to newer moraines.

The Stone Hand-hammer.—A special study has been published by Mr. J. D. McGuire, of Ellicott City, Md., of the stone hand-hammer, which he believes was probably the tool upon which races living in the stone age relied more than upon any other object to fashion other stone implements. There is no implement, he says, more common among the relics of the stone age, none the uses of which have been less discussed by archæologists, and none more deserving of thorough discussion. The objects seem to be comprised in three types: First, a flattened or oblong ellipsoid, having a pit on one or both sides, the pits being probably intended as finger-holds to relieve the index-finger from the constant jar occasioned by quickly repeated blows on a hard surface. The periphery of these will often be found quite smooth, at other times rough, according as it has been last used as a hammer or as a rubber; for, besides using the hammer to peck his axe or celt into shape, he afterward polished his implement with it. Often one or both of the flattened sides show the effect of rubbing. A second type is the spherical implement, slightly flattened at the poles, showing a battered and commonly a

smooth surface. These two types may be considered common all over the world. The third type is the grooved hammer, of the use and distribution of which little is known. It was evidently intended for hafting, and that would interfere with its use as a rubber. All three types vary greatly in dimensions, but, as a rule, the first two are of a size suitable for hand-use for hammering and for rubbing. With these hammers the author believes that other implements were dressed by pecking, and superficial effects were produced which have not been otherwise accounted for, or even remarked. He further goes on to maintain that they had a much more extensive use than has been contemplated, and that many of the Egyptian and the ancient Greek works of art were prepared and dressed with them.

Curious Feature of the Coal-borings at Manchester, England.—The Manchester coal-field, England, according to an article in Chambers's Journal, is a seat of great activity and advancement. Difficulties have been encountered and overcome there, and depths have been reached, which are not thought of elsewhere in the kingdom. The Ashton Moss mine lies at a depth of about a thousand yards below the surface. It presents the curious phenomenon of the boring passing down from one seam of coal to another one four hundred yards geologically higher. This is occasioned by the occurrence of a reversed fault, by which the seams are thrown into this curious position relative to one another. The natural temperature at the bottom of the mine, 84° Fahr., is much lower than the theoretical temperature calculated upon by the Royal Coal Commission. The barometer stands three inches higher than at the surface.

The "Typical American" Diet.—Noticing and criticising the paper of N. E. Yorke Davies, in the July number of the Monthly, on The Proper Diet for Hot Weather, the Boston Medical and Surgical Journal says that "the 'typical American' takes an early breakfast, when he indulges freely in fruit, and never omits a first course of oatmeal and milk, cracked wheat, or hominy; this is followed by dry toast or buttered toast, an egg and a little cold meat or fresh fish, and a cup of coffee sweetened with sugar, not saccharine, which is reserved for the diabetic. He would be glad of cream if it can be obtained. His dinner is the principal meal, and is always taken near the middle of the day. This is composed of soup, three or four ounces of broiled fish, roast meat, or fowl, from four to six ounces of green vegetables (green peas, green beans, stewed turnips, onions, squash), four ounces of potatoes with meat gravy, with pickles and jelly *ad lib.* The last course, the apple, custard, or berry pie of our forefathers, doubtless does not deserve all the abuse which has been heaped upon it by our English cousins, especially when it is light, without too much shortening, and with a well-cooked bottom crust. The last meal, the supper, is taken rather early (as soon as six o'clock), and is designed to be a plain, light, substantial meal of bread and butter or tea-rolls, a little stewed fruit for relish, and one or two cups of tea. The 'average American' seldom eats lunches."

NOTES.

Of the value of anthropological research, in one direction at least, Dr. Alexander Macalister says that if we should ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, with such a knowledge we should be able to advance in that practical branch of anthropology, the science of education, and to make progress in sociology, a study which does for the community what the science of education does for the individual.

Among the results of the recent earthquake in Japan, as described by Prof. Milne at the meeting of the British Association, were the depression of a valley of about nineteen feet and for a distance of thirty miles, thus forming a great geological fault, and the curving of a railway line running along an embankment and bridge in the path of the earthquake.

The influence of food and surroundings on color was illustrated in a paper at the British Association by Mr. E. B. Poulton, on the colors of lepidopterous larvæ. Several members of a large brood of caterpillars of the pepper moth were exhibited which had been reared under different conditions. Those which had been confined among green leaves and twigs became green; those which had had black and brown twigs mingled with their food were brown or black; while others which had been reared among spills of white paper had made a pathetic attempt to imitate

their surroundings. Experiments with artificial colors showed that both blue and red tended to produce a dark coloration, especially the former; while, strangely enough, painted twigs did not produce the same effect as those whose tints were natural. Mr. Poulton was able to show that the sensory stimulus producing the change did not act through the eye, as in the case of the chameleon, frog, and sole, but through the skin. It consists, moreover, in the formation of definite pigment, and hence is not so rapid as in those animals. It is possible to modify the color of a caterpillar only once or twice in its lifetime.

THE past year, said Dr. Alexander Macalister, in the anthropological address at the British Association, had not been fertile in discoveries bearing on questions of popular interest. No new light had been shed on the darkness that enshrouded the origin of man; but in this connection Dr. Louis Robinson had, from a series of observations on the prehensile power of the hands of children at birth, arrived at the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather—namely, that there still survived in the human structure and habit traces of our probably arboreal ancestry.

OF one hundred and three members of the British Association of last year who were anthropometrically examined at Cardiff, seventy-eight were men, and the mean stature of the whole was sixty-eight inches, being one inch above the average stature of the people of the British Isles.

THE third report of the committee of the British Association to arrange for the collection, preservation, and systematic registration of photographs of points of geological interest says that, while the photographs collected during the past two years are less in number than those of the previous period, a greater proportion are of high scientific interest and illustrate features of real geological importance. But considerable work is yet required to be done toward the completion of a scheme for the full illustration of the geological features of the United Kingdom.

A PRELIMINARY account was read in the British Association by Dr. Buchan of oceanic circulation as deduced from the Challenger observations. The author was convinced that a thorough knowledge of the subject could only be attained after a study of the prevailing winds, as the currents followed the winds. He then described the circulation of currents in the North Atlantic, and said that these currents were lost at a depth of over five hundred fathoms, below which point the ocean had always a constant temperature at all depths. The same condition was reached at fifteen hundred fathoms in the Pacific Ocean. He went on to trace the course of the warm dense salt water issuing below the surface from the Mediterranean through the Strait of Gibraltar. This, he said, traveled northward, skirting the west coast of Europe, and thus warming the water even to the north of Norway. He considered that the current was sufficiently warm and strong to prevent the entrance of icebergs into the North Sea.

THE observations of dust in the air, made eight times a day last year at the top of Ben Nevis, showed well-marked variations in the amounts present at different times of day. Further, it was found that thick, dry fogs contain a large amount of dust, whereas the thin, wet mists contain little or none.

IN the course of his paper in the British Association on the Application of Interference Methods to Spectroscopic Measurement, Prof. Michaelson, of America, found that the results seemed to show that every line of the spectrum is compound, though in many cases the two components are very close together, and have very unequal intensities. The red line of oxygen has three distinct components; the red line of hydrogen is an extremely close double, with nearly equal components; and the green line of cadmium has two components, one of which is ten times as intense as the other.

IN illustration of results obtained by the Rev. T. J. Smith in inductoscript (writing by induction currents), Mr. R. E. Baynes, in the British Association, caused the spark of an induction coil to be passed from a coin to a photographic plate on which it was placed. The plate was then developed, and showed an image of the coin. On performing the experiment in a vacuum no such result was obtained. The effect could be got with bromide paper as well as with plates.

THE American Association voted grants of a hundred dollars each to Prof. Hart, for investigations in chemistry; to Prof. Joseph Jastrow, in psychology; and to the physical table to be located at Naples.

DESCRIBING, in the American Association, the Prehistoric Earthworks of Henry County, Ind., Mr. T. B. Redding said that there were in that county ten curiously formed mounds, surrounded by inclosures, and a number of additional ones, though some of them are not so evident as to be noticed by the casual observer. There are also six inclosures in which mounds do not appear. They may have been obliterated. The mounds range from twenty to a hundred and fifty feet in diameter, and the inclosures are from a hundred to two hundred and fifty feet in diameter. Many of the mounds crumble away on being exposed by taking off the turf covering, while others are in a good state of preservation. A number of relics and skeletons were exhibited during the reading of the paper.